

AAAAAA	SSSSS	PPPPP	EEEEE	NN	N	PPPPP	L	U	U	SSSSS
A A	S	P P	E	N N	N	P P	L	U	U	S
AAAAAA	SSSSS	PPPPP	EEEEE	N	N N	PPPPP	L	U	U	SSSSS
A A	S	P	E	N	NN	P	L	U	U	S
A A	SSSSS	P	EEEEE	N	N	P	LLLLL	UUUUU		SSSSS

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 ASPEN TECHNOLOGY, INC.
 251 VASSAR STREET
 CAMBRIDGE, MASSACHUSETTS 02139
 617-497-9010

VERSION: DOS-386
 RELEASE: 8.4-1
 INSTALLATION: AWDHOU

HOTLINE:
 U.S.A. 617-497-9010
 EUROPE 31-70-3541051

JULY 4, 1991
 THURSDAY
 3:16:07 P.M.

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE I
CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES

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PLUS COMPUTER SOFTWARE SYSTEM IS USED FOR FLOWSHEET SIMULATION.

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CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
RUN CONTROL SECTION

RUN CONTROL INFORMATION

THIS VERSION OF ASPEN PLUS LICENSED TO AWD TECHNOLOGIES, INC.
TYPE OF RUN: NEW

INPUT FILE NAME: RUN1.inp

OUTPUT PROBLEM DATA FILE NAME: RUN1 VERSION NO. 1
LOCATED IN: C:\ASPEN\RUN1

PDF SIZE USED FOR INPUT TRANSLATION:
NUMBER OF FILE RECORDS (PSIZE) = 99999
NUMBER OF IN-CORE RECORDS = 400
PSIZE NEEDED FOR SIMULATION = 62

CALLING PROGRAM NAME: RUN1
LOCATED IN: C:\ASPEN\RUN1

SIMULATION REQUESTED FOR ENTIRE FLOWSHEET

BLOCK STATUS

*
* ALL UNIT OPERATION BLOCKS WERE COMPLETED NORMALLY
*

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 2
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 FLOWSHEET SECTION

FLOWSHEET CONNECTIVITY BY STREAMS

STREAM	SOURCE	DEST	STREAM	SOURCE	DEST
4	---	B1	3	---	B1
1	B1	---	2	B1	---

FLOWSHEET CONNECTIVITY BY BLOCKS

BLOCK	INLETS	OUTLETS
B1	3 4	1 2

COMPUTATIONAL SEQUENCE

SEQUENCE USED WAS:
 B1

OVERALL FLOWSHEET BALANCE

*** MASS AND ENERGY BALANCE ***			RELATIVE DIFF.
	IN	OUT	
CONVENTIONAL COMPONENTS (LBMOL/HR)			
C6H6	0.960135	0.960841	-0.734133E-03
H2O	9125.73	9125.73	0.728926E-07
TOTAL BALANCE			
MOLE(LBMOL/HR)	9126.69	9126.69	-0.440317E-08
MASS(LB/HR)	164475.	164475.	-0.262148E-06
ENTHALPY(BTU/HR)	-0.108604E+10	-0.108604E+10	-0.869333E-07

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 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

COMPONENTS

ID	TYPE	FORMULA	NAME OR ALIAS	REPORT NAME
C6H6	C	C6H6	C6H6	C6H6
H2O	C	H2O	H2O	H2O
LISTID			SUPERCRITICAL COMPONENT LIST	
LIST1			C6H6 H2O	

PARAMETER VALUES

CONVENTIONAL COMPONENT - UNARY PARAMETER TABLE

PARAMETER	COMPONENTS		
NAME/SET/EL	C6H6	H2O	
ZC	1	2.71000-01	2.29000-01
TC	1	5.62100+02	6.47300+02
PC	1	4.89400+06	2.20483+07
MW	1	7.81140+01	1.80150+01
PLXANT	1 1	7.38624+01	6.51544+01
	2	-5.97044+03	-6.84291+03
	3	0.0	0.0
	4	5.53760-03	2.78351-03
	5	-8.07976 00	-6.13638 00
	6	6.61298-18	3.31168-18
	7	6.00000 00	6.00000 00
	8	2.93361+02	3.19267+02
	9	5.62100+02	6.47300+02
TB	1	3.53300+02	3.73200+02
CPIG	1 1	-3.39173+04	3.37381+04
	2	4.74364+02	-7.01756 00
	3	-3.01701-01	2.72961-02
	4	7.13012-05	-1.66465-05
	5	0.0	4.29761-09
	6	0.0	-4.16961-13
	7	3.00000+02	2.00000+02
	8	1.41050+03	3.00000+03
	9	3.32560+04	3.32560+04
	10	1.10550 00	1.89780-20
	11	1.87900 00	9.28460 00
DHVLT	1 1	3.07814+07	4.06831+07
	2	3.53300+02	3.73200+02
	3	3.49117-01	3.10646-01
	4	0.0	0.0
	5	2.78700+02	2.73200+02
OMEGA	1	2.12000-01	3.44000-01
DHFORM	1	8.29824+07	-2.41997+08
DGFORM	1	1.29749+08	-2.28767+08
VLSTD	1 1	8.85091-02	1.80500-02
	2	MISSING	MISSING
	3	MISSING	MISSING
SG	1	8.84400-01	1.00000 00
API	1	2.85000+01	1.00000+01
WATSOL	1 1	4.88180 00	MISSING

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 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

	2	-3.18137+03	MISSING
	3	0.0	0.0
	4	2.75000+02	0.0
	5	5.33000+02	1.00000+03
CHARGE	1	0.0	0.0
HIGPY	1	1	MISSING MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	0.0	0.0
	9	0.0	0.0
	10	1.00000+03	1.00000+03
PSEUDO	1	MISSING	MISSING
CPIGDP	1	1	4.44200+04 3.33630+04
	2	2.32050+05	2.67900+04
	3	1.49460+03	2.61050+03
	4	1.72130+05	8.89600+03
	5	-6.78150+02	1.16900+03
	6	2.00000+02	1.00000+02
	7	1.50000+03	2.27315+03
VC	1	2.58779-01	5.58953-02
RKTZRA	1	2.69017-01	2.43172-01
VCRKT	1	MISSING	MISSING
RACKET	1	1	MISSING MISSING
	2	MISSING	MISSING
	3	2.85714-01	2.85714-01
VB	1	9.55084-02	1.96361-02
MUP	1	0.0	5.69210-25
LJPAR	1	1	MISSING MISSING
	2	MISSING	MISSING
STKPAR	1	1	MISSING MISSING
	2	MISSING	MISSING
MUVDIP	1	1	3.13400-08 1.78510-07
	2	9.67600-01	8.13000-01
	3	7.90000 00	3.04720+02
	4	0.0	0.0
	5	0.0	0.0
	6	2.78680+02	3.73150+02
	7	1.00000+03	1.07310+03
TRNSWT	1	1	0.0 0.0
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
MULAND	1	1	-1.16427+01 -1.22605+01
	2	1.25638+03	1.51568+03
	3	0.0	0.0
	4	2.78700+02	2.73200+02
	5	5.62100+02	6.47300+02
MULDIP	1	1	6.76360 00 -2.45690+02
	2	3.36410+02	9.76350+03
	3	-2.68700 00	3.83790+01

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 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

	4	0.0	-4.27430-02
	5	0.0	1.00000 00
	6	2.78680+02	2.73160+02
	7	5.45000+02	6.46150+02
KVDIP	1 1	1.65200-05	6.92950-05
	2	1.31170 00	1.12540 00
	3	4.91000+02	8.47680+02
	4	0.0	-1.50000+05
	5	0.0	0.0
	6	3.39150+02	3.73150+02
	7	1.00000+03	1.07310+03
KLDIP	1 1	2.39100-01	-4.32000-01
	2	-3.18500-04	5.72550-03
	3	0.0	-8.07800-06
	4	0.0	1.86100-09
	5	0.0	0.0
	6	2.73100+02	2.73160+02
	7	4.13100+02	6.33150+02
DVBLNC	1	1.00000 00	1.00000 00
DLWC	1	1.00000 00	1.00000 00
CHI	1	0.0	0.0
SIGDIP	1 1	7.19500-02	1.85480-01
	2	1.23890 00	2.71700 00
	3	0.0	-3.55400 00
	4	0.0	2.04700 00
	5	0.0	0.0
	6	2.78680+02	2.73160+02
	7	5.62160+02	6.47130+02
THRSWT	1 1	0.0	0.0
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	0.0	0.0
NATOM	1 1	6.00000 00	0.0
	2	6.00000 00	2.00000 00
	3	0.0	1.00000 00
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	0.0	0.0
	9	0.0	0.0
	10	0.0	0.0
	11	0.0	0.0
DHAQFM	1	0.0	0.0
WAGNER	1 1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
CPIGYM	1 1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0

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 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

	4	1.00000 00	1.00000 00
HCOM	1	-3.13600+09	0.0
DNLDIP	1 1	1.01620 00	5.45900 00
	2	2.65500-01	3.05420-01
	3	5.62160+02	6.47130+02
	4	2.82120-01	8.10000-02
	5	0.0	0.0
	6	2.78680+02	2.73160+02
	7	5.62160+02	3.33150+02
PSANT	1 1	MISSING	MISSING
	2	MISSING	MISSING
	3	0.0	0.0
	4	0.0	0.0
	5	1.000000+03	1.000000+03
CPSPO1	1 1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	1.000000+03	1.000000+03
DHSFRM	1	0.0	0.0
CPSDIP	1 1	7.40000+03	-2.62490+02
	2	6.24900+02	1.40520+02
	3	-2.68740 00	0.0
	4	7.31600-03	0.0
	5	0.0	0.0
	6	4.000000+01	3.15000 00
	7	2.78680+02	2.73150+02
DGSFRM	1	0.0	0.0
VSPOLY	1 1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	1.000000+03	1.000000+03
DNSDIP	1 1	1.30610+01	5.30300+01
	2	-3.57140-04	-7.84090-03
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	2.73100+02	2.33150+02
	7	2.78680+02	2.73150+02
KSPOLY	1 1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	1.000000+03	1.000000+03
GMUQR	1	3.18780 00	9.20000-01
GMUQQ	1	2.40000 00	1.40000 00
GMUQQ1	1	MISSING	MISSING

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 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

DHVLDP	1	1	4.75000+07	5.20530+07
		2	4.52380-01	3.19900-01
		3	5.34000-02	-2.12000-01
		4	-1.18100-01	2.57950-01
		5	0.0	0.0
		6	2.78680+02	2.73160+02
		7	5.62160+02	6.47130+02
DHVLB	1		3.07814+07	4.06831+07
VLBROC	1	1	MISSING	MISSING
		2	0.0	0.0

CONVENTIONAL COMPONENT - BINARY PARAMETER TABLES

TABLE FOR RKT KIJ SET = 1 ELEMENT = 1

	C6H6	H2O
C6H6	MISSING	MISSING
H2O	MISSING	MISSING

TABLE FOR GMUQA SET = 1 ELEMENT = 1

	C6H6	H2O
C6H6	0.0	-7.25449-02
H2O	8.29735-03	0.0

TABLE FOR GMUQB SET = 1 ELEMENT = 1

	C6H6	H2O
C6H6	0.0	-8.79403+02
H2O	-3.63749+02	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 1

	C6H6	H2O
C6H6	MISSING	7.31570+01
H2O	MISSING	MISSING

TABLE FOR HENRY SET = 1 ELEMENT = 2

	C6H6	H2O
C6H6	0.0	-6.27600+03
H2O	0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 3

	C6H6	H2O
C6H6	0.0	-8.44430 00
H2O	0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 4

	C6H6	H2O
C6H6	0.0	6.26000-06
H2O	0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 5

	C6H6	H2O
C6H6	0.0	2.78680+02
H2O	0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 6

C6H6	H2O
------	-----

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CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

C6H6	2.00000+03	5.62160+02
H2O	2.00000+03	2.00000+03

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 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 U-O-S BLOCK SECTION

BLOCK: B1 MODEL: RADFRAC

INLETS - 3	STAGE 1
	4 STAGE 10
OUTLETS - 1	STAGE 1
	2 STAGE 10

PROPERTY OPTION SET: SYSOP11A UNIQUAC / REDLICH-KWONG
 HENRY-COMPS ID: LIST1

*** MASS AND ENERGY BALANCE ***			RELATIVE DIFF.
	IN	OUT	

TOTAL BALANCE

MOLE(LBMOL/HR)	9126.69	9126.69	-0.440317E-08
MASS(LB/HR)	164475.	164475.	-0.262148E-06
ENTHALPY(BTU/HR)	-0.108604E+10	-0.108604E+10	-0.869333E-07

**** INPUT DATA ****

**** INPUT PARAMETERS ****

NUMBER OF STAGES	10
ALGORITHM OPTION	STANDARD
ABSORBER OPTION	NO
INITIALIZATION OPTION	STANDARD
HYDRAULIC PARAMETER CALCULATIONS	NO
INSIDE LOOP CONVERGENCE METHOD	NEWTON
MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS	25
MAXIMUM NO. OF INSIDE LOOP ITERATIONS	10
MAXIMUM NUMBER OF FLASH ITERATIONS	50
FLASH TOLERANCE	0.000100000
OUTSIDE LOOP CONVERGENCE TOLERANCE	0.000100000

**** COL-SPECS ****

CONDENSER DUTY (W/O SUBCOOL)	BTU/HR	0.0
REBOILER DUTY	BTU/HR	0.0
MASS VAPOR DIST / TOTAL DIST		1.00000

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 10
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 U-O-S BLOCK SECTION

BLOCK: B1 MODEL: RADFRAC (CONTINUED)

***** PROFILES *****

P-SPEC	STAGE	1	PRES, PSI	16.0000
TEMP-EST	STAGE	1	TEMP, F	215.000
		10		226.000

***** TRAY MURPHREE EFFICIENCY *****

STAGE	1	EFFICIENCY	0.80000
	10		0.80000

***** RESULTS *****

TOP STAGE TEMPERATURE	F	216.321
BOTTOM STAGE TEMPERATURE	F	225.364
TOP STAGE LIQUID FLOW	LBMOL/HR	8,445.37
BOTTOM STAGE LIQUID FLOW	LBMOL/HR	8,491.47
TOP STAGE VAPOR FLOW	LBMOL/HR	635.218
BOTTOM STAGE VAPOR FLOW	LBMOL/HR	824.804
CONDENSER DUTY (W/O SUBCOOL)	BTU/HR	0.0
REBOILER DUTY	BTU/HR	0.0

***** MAXIMUM FINAL RELATIVE ERRORS *****

DEW POINT	0.79318E-05	STAGE= 10
BUBBLE POINT	0.79320E-05	STAGE= 10
COMPONENT MASS BALANCE	0.43536	STAGE= 10 COMP=C6H6
ENERGY BALANCE	0.19497E-05	STAGE= 10

***** PROFILES *****

STAGE	TEMPERATURE F	PRESSURE PSI	ENTHALPY BTU/LBMOL		HEAT DUTY BTU/HR
			LIQUID	VAPOR	
1	216.32	16.000	-0.12038E+06	-0.10272E+06	
2	217.48	16.333	-0.12036E+06	-0.10293E+06	
8	223.48	18.333	-0.12025E+06	-0.10288E+06	
9	224.43	18.667	-0.12023E+06	-0.10288E+06	
10	225.36	19.000	-0.12021E+06	-0.10287E+06	

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 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 U-O-S BLOCK SECTION

BLOCK: B1 MODEL: RADFRAC (CONTINUED)

STAGE	FLOW RATE		FEED RATE			PRODUCT RATE	
	LBMOL/HR		LIQUID	VAPOR	LIQUID	VAPOR	LBMOL/HR
1	8445.	635.2					
2	8456.	753.2					
8	8509.	807.9					
9	8517.	816.4					
10	8491.	824.8				799.3338	8491.4707

***** X-PROFILE *****

STAGE	C6H6		H2O
	1	.94034E-06	1.0000
2	.88002E-08	1.0000	
8	.41390E-08	1.0000	
9	.42053E-08	1.0000	
10	.42812E-08	1.0000	

***** Y-PROFILE *****

STAGE	C6H6		H2O
	1	.15126E-02	.99849
2	.15536E-04	.99998	
8	.78170E-05	.99999	
9	.78760E-05	.99999	
10	.79368E-05	.99999	

***** K-VALUES *****

STAGE	C6H6		H2O
	1	2006.6	.99811
2	1989.4	.99999	
8	1885.1	1.0000	
9	1869.3	1.0000	
10	1853.9	1.0000	

SENT BY FAX

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1	2	3	4
FROM :	B1	B1	---	---
TO :	---	---	B1	B1
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.5950-03	0.9601	0.0
H2O	2.8044	8453.8155	8326.3946	130.2253
COMPONENTS: LB/HR				
C6H6	74.2504	0.7495	75.0000	0.0
H2O	50.5217	1.5230+05	1.5000+05	2346.0096
TOTAL FLOW:				
LBMOL/HR	3.7549	8453.8251	8327.3548	130.2253
LB/HR	124.7722	1.5230+05	1.5007+05	2346.0096
CUFT/HR	1646.2341	2666.4957	2602.7570	9425.5303
STATE VARIABLES:				
TEMP F	201.7299	216.3655	201.4000	337.8307
PRES PSI	16.0000	16.0203	16.0000	114.0000
VFRAC	0.9998	0.0	0.0	1.0000
LFRAC	1.3538-04	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.7259+04	-1.2038+05	-1.2064+05	-1.0207+05
BTU/LB	-2024.1318	-6682.2996	-6694.3193	-5665.6518
BTU/HR	-2.5256+05	-1.0177+09	-1.0046+09	-1.3292+07
ENTROPY:				
BTU/LBMOL-R	-14.0528	-34.7244	-35.1401	-11.5627
BTU/LB-R	-0.4229	-1.9275	-1.9498	-0.6418
DENSITY:				
LBMOL/CUFT	2.2809-03	3.1703	3.1994	1.3816-02
LB/CUFT	7.5793-02	57.1147	57.6600	0.2489
Avg MW	33.2285	18.0150	18.0219	18.0150

Basis:
 TR. TRAYS = 5
 EFF = 80%
 PRESS. = 16 PSIA

SENT BY ARIAD

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1	2	3	4
FROM :	B1	B1	----	----
TO :	----	----	B1	B1
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.5935-03	0.9601	0.0
H2O	2.7358	8451.9487	8326.3946	128.2898
COMPONENTS: LB/HR				
C6H6	74.2506	0.7493	75.0000	0.0
H2O	49.2858	1.5226+05	1.5000+05	2311.1419
TOTAL FLOW:				
LBMOL/HR	3.6863	8451.9583	8327.3548	128.2898
LB/HR	123.5364	1.5226+05	1.5000+05	2311.1419
CUFT/HR	1830.2904	2654.3663	2591.8276	9285.4427
STATE VARIABLES:				
TEMP F	194.9944	209.6017	194.7000	337.8307
PRES PSI	14.0000	14.0212	14.0000	114.0000
VFRAC	0.9998	0.0	0.0	1.0000
LFRAC	1.2622-04	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.6671+04	-1.2051+05	-1.2077+05	-1.0207+05
BTU/LB	-1989.4933	-6689.3325	-6701.2283	-5665.6518
BTU/HR	-2.4577+05	-1.0185+09	-1.0057+09	-1.3094+07
ENTROPY:				
BTU/LBMOL-R	-14.0130	-34.9111	-35.3280	-11.5627
BTU/LB-R	-0.4181	-1.9378	-1.9602	-0.6418
DENSITY:				
LBMOL/CUFT	2.0141-03	3.1841	3.2129	1.3816-02
LB/CUFT	6.7496-02	57.3630	57.9031	0.2489
AVG MW	33.5117	18.0150	18.0219	18.0150

Basis:

TH. TRAYS = 5
 EFF = 80%
 PRESS. = 14 PSIA

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1	2	3	4
FROM :	B1	B1	----	----
TO :	----	----	B1	B1
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.6013-03	0.9601	0.0
H2O	2.6283	8451.2297	8326.3946	127.4634
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	47.3493	1.5225+05	1.5000+05	2296.2538
TOTAL FLOW:				
LBMOL/HR	3.5788	8451.2393	8327.3548	127.4634
LB/HR	121.5993	1.5225+05	1.5007+05	2296.2538
CUFT/HR	2050.9071	2641.3509	2579.4486	9225.6272
STATE VARIABLES:				
TEMP F	187.2610	201.9925	187.0000	337.8307
PRES PSI	12.0000	12.0242	12.0000	114.0000
VFRAC	0.9998	0.0	0.0	1.0000
LFRAC	1.1744-04	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.5668+04	-1.2065+05	-1.2091+05	-1.0207+05
BTU/LB	-1932.7228	-6697.2136	-6709.1368	-5665.6518
BTU/HR	-2.3502+05	-1.0196+09	-1.0069+09	-1.3010+07
ENTROPY:				
BTU/LBMOL-R	-14.0211	-35.1226	-35.5456	-11.5627
BTU/LB-R	-0.4126	-1.9496	-1.9723	-0.6418
DENSITY:				
LBMOL/CUFT	1.7450-03	3.1995	3.2283	1.3816-02
LB/ CUFT	5.9291-02	57.6408	58.1810	0.2489
AVG MW	33.9770	18.0150	18.0219	18.0150

BASIS:

TH. TRAYS = 5
 EFF = 80%
 PRESS = 12 PSIA

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 1
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 ----	4 ----
FROM :	---	---	B1	B1
TO :	---	---	---	---
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.6013-03	0.9601	0.0
H2O	2.5595	8448.4336	8326.3946	124.5985
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	46.1107	1.5220+05	1.5000+05	2244.6428
TOTAL FLOW:				
LBMOL/HR	3.5101	8448.4432	8327.3548	124.5985
LB/HR	120.3607	1.5220+05	1.5007+05	2244.6428
CUFT/HR	2384.5151	2626.0391	2565.8456	9018.2704
STATE VARIABLES:				
TEMP F	178.6160	193.2547	178.4000	337.8307
PRES PSI	10.0000	10.0288	10.0000	114.0000
VFRAC	0.9998	0.0	0.0	1.0000
LFRAC	1.0572-04	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.5036+04	-1.2081+05	-1.2107+05	-1.0207+05
BTU/LB	-1896.6603	-6706.2232	-6717.9295	-5665.6518
BTU/HR	-2.2828+05	-1.0207+09	-1.0082+09	-1.2717+07
ENTROPY:				
BTU/LBMOL-R	-13.9376	-35.3678	-35.7909	-11.5627
BTU/LB-R	-0.4064	-1.9632	-1.9859	-0.6418
DENSITY:				
LBMOL/CUFT	1.4720-03	3.2171	3.2454	1.3816-02
LB/CUFT	5.0476-02	57.9577	58.4894	0.2489
AVG MW	34.2897	18.0150	18.0219	18.0150

BASIS:

TH. RAYS = 5
 EFF. = 80%
 PRESS. = 10 PSIA

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1	2	3	4
FROM :	B1	B1	----	----
TO :	----	----	B1	B1
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.6013-03	0.9601	0.0
H2O	2.4292	8445.7100	8326.3946	121.7445
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	43.7627	1.5215+05	1.5000+05	2193.2282
TOTAL FLOW:				
LBMOL/HR	3.3797	8445.7196	8327.3548	121.7445
LB/HR	118.0127	1.5215+05	1.5007+05	2193.2282
CUFT/HR	3002.5707	2603.8096	2545.4081	8811.7027
STATE VARIABLES:				
TEMP F	165.3560	180.0205	165.2000	337.8307
PRES PSI	7.5000	7.5375	7.5000	114.0000
VFRAC	0.9999	0.0	0.0	1.0000
LFRAC	8.9507-05	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.3721+04	-1.2106+05	-1.2131+05	-1.0207+05
BTU/LB	-1824.9184	-6719.7861	-6731.3423	-5665.6518
BTU/HR	-2.1536+05	-1.0224+09	-1.0102+09	-1.2426+07
ENTROPY:				
BTU/LBMOL-R	-13.8578	-35.7435	-36.1720	-11.5627
BTU/LB-R	-0.3968	-1.9840	-2.0071	-0.6418
DENSITY:				
LBMOL/CUFT	1.1256-03	3.2436	3.2715	1.3816-02
LB/CUFT	3.9304-02	58.4337	58.9591	0.2489
AVG MW	34.9173	18.0150	18.0219	18.0150

Basis:

IN. TRAYS = 5
 EFF. = 80%
 PRESS. = 7.5 PSIA

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 ----	4 ----
FROM :	----	----	B1	B1
TO :	----	----	----	----
SUBSTREAM: MIXED				
PHASE:	MIXED	LIQUID	MIXED	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.6013-03	0.9601	0.0
H2O	2.2862	8441.8421	8326.3946	117.7336
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	41.1862	1.5208+05	1.5000+05	2120.9720
TOTAL FLOW:				
LBMOL/HR	3.2367	8441.8517	8327.3548	117.7336
LB/HR	115.4362	1.5208+05	1.5000+05	2120.9720
CUFT/HR	4199.6948	2575.0983	2890.1705	8521.3998
STATE VARIABLES:				
TEMP F	147.8055	162.4570	147.7000	337.8307
PRES PSI	5.0000	5.0510	5.0000	114.0000
VFRAC	0.9999	0.0	3.4361-05	1.0000
LFRAC	6.6382-05	1.0000	0.9999	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.2182+04	-1.2138+05	-1.2163+05	-1.0207+05
BTU/LB	-1743.5510	-6737.6302	-6748.9388	-5665.6518
BTU/HR	-2.0127+05	-1.0247+09	-1.0128+09	-1.2017+07
ENTROPY:				
BTU/LBMOL-R	-13.6870	-36.2509	-36.6854	-11.5627
BTU/LB-R	-0.3837	-2.0122	-2.0356	-0.6418
DENSITY:				
LBMOL/CUFT	7.7071-04	3.2782	2.8812	1.3816-02
LB/CUFT	2.7487-02	59.0581	51.9260	0.2489
AVG MW	35.6642	18.0150	18.0219	18.0150

BASIS:

TH. TRAYS = 5
 EFF. = 80%
 PRESS. < 5 PSIA

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 12
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1 B1 -----	2 B1 -----	3 ----- B1	4 ----- B1
SUBSTREAM: MIXED				
PHASE:				
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.6019-03	0.9601	0.0
H2O	2.2063	8434.6739	8326.3946	110.4857
COMPONENTS: LB/HR				
C6H6	74.2499	0.7500	75.0000	0.0
H2O	39.7481	1.5195+05	1.5000+05	1990.4000
TOTAL FLOW:				
LBMOL/HR	3.1569	8434.6835	8327.3548	110.4857
LB/HR	113.9981	1.5195+05	1.5000+05	1990.4000
CUFT/HR	9678.6162	2521.0975	6145.6537	7996.8023
STATE VARIABLES:				
TEMP F	112.9681	127.6800	113.0000	337.8307
PRES PSI	2.0000	2.1100	2.0000	114.0000
VFRAC	1.0000	0.0	1.4402-04	1.0000
LFRAC	0.0	1.0000	0.9998	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.1555+04	-1.2201+05	-1.2225+05	-1.0207+05
BTU/LB	-1704.6251	-6772.4360	-6783.2654	-5665.6518
BTU/HR	-1.9432+05	-1.0291+09	-1.0180+09	-1.1277+07
ENTROPY:				
BTU/LBMOL-R	-12.7547	-37.2867	-37.7342	-11.5627
BTU/LB-R	-0.3532	-2.0697	-2.0938	-0.6418
DENSITY:				
LBMOL/CUFT	3.2618-04	3.3456	1.3550	1.3816-02
LB/CUFT	1.1778-02	60.2719	24.4197	0.2489
AVG MW	36.1104	18.0150	18.0219	18.0150

Basis:

5 Theor. trays
 Murphree eff. = 80%
 Press. = 2 psia

APPENDIX N

E. M. Rosen MCC Operations F3WA (4-6412)

Date: April 13, 1993 cc J. R. Deam F3WC*
Subj: Process Simulator Comparison L. D. Eckelman F3WC
Benzene Stripping A. H. Larsen F3WC*
Ref: B. C. Davis, Exxon Chemical Co. March 22, 1993
To: J. M. Schroy F3WA

I have compared the results of the ASPEN PLUS simulations provided by B. C. Davis of Exxon Chemical Co. (attached) to that of FLOWTRAN (Monsanto) and HYSIM (Hyprotech).

For the benzene stripping, the results of all three simulators are comparable.

Attached will find the complete FLOWTRAN results and the HYSIM results for case 1A.

E. M. Rosen
E. M. Rosen

***Without Full Attachments**

Steam Stripping of Benzene - Comparison of Simulators

Case	Top/Bottom Absorber Pressure (Psia)	Feed Vapor Fraction	Feed Temp F	<---- Steam Feed Rate lb/hr---->		
				ASPEN+	FLOWTRAN	HYSIM
1A	16 /16.0203	Subcooled	201.4	2346	2371	2203
2A	14 /14.0212	Subcooled	194.7	2311	2340	2178
3A	12 /12.0242	Subcooled	187.0	2296	2329	2173
4A	10 /10.0288	Subcooled	178.4	2244	2282	2130
5A	7.5/ 7.5375	Subcooled	165.2	2193	2236	2096
6	5.0/ 5.0510	.000034361		2120	2253	2483
7	2.0/ 2.1100	.00014402		1990	2088	2200

<---- Ratio of Steam Rate to Feed Rate--->

Case	ASPEN+	FLOWTRAN	HYSIM
1A	.01563	.01580	.01468
2A	.01540	.01559	.01451
3A	.01530	.01552	.01448
4A	.01495	.01521	.01419
5A	.01461	.01490	.01397
6	.01413	.01501	.01655
7	.01326	.01391	.01466

Notes:

1. The ASPEN+ results dated July 4, 1991 were taken from the transmittal of B. C. Davis of EXXON Chemicals on 3/25/93.
2. All simulators used steam at the saturation temperature as determined by that simulator: At 114 psia saturated steam:
ASPEN+: 337.8307 F FLOWTRAN: 337.33 F HYSIM: 337.4501 F
3. The physical properties of the pure components were taken as those of each simulator.
4. The VLE for the binary benzene/water used the Chien-Null version of the van-Laar equation. The same binary pair coefficients were used in both FLOWTRAN and HYSIM.

Chien-Null Reference: Chien, H. H. and H. R. Null
 "Generalized Multicomponent Equation for Activity Coefficient Calculation", AIChEJ vol 18, 1177 (1972)

Benzene/Water Reference: Sorensen and Arlt
 "Liquid-Liquid Equilibrium Data Collection" DECHEMA Data Series, Vol V Part 1.

5. ASPEN PLUS was run with 5 stages (80% Murphree Efficiency). FLOWTRAN and HYSIM were run with 4 theoretical stages.
6. The feed temperature was determined by each simulator in cases 6A and 7A at the specified vapor fraction:

	ASPEN+	FLOWTRAN	HYSIM
Case 6A:	147.7 F	147.10 F	144.63 F
Case 7A:	113.0 F	112.68 F	111.49 F

7. Each simulator determined the steam rate to reduce the benzene in the bottoms to 0.75 lb/hr.

TITLE CASE 1A
PROPS 2 1 1 1 6 2 2
.RETR BENZENE WATER
.TYPE PAIR
.PROJ CED.ARMS.WBH6195
.RETR BENZENE/WATER/VAN-LAAR
UNIT M1 MULPY STM/STMA
PARAM M1 1 1.
UNIT COL1 AFRAC FEED STMA / BOTT 0 0 0 0 OVHD
PARAM COL1 1 216 201 16.0203 16.00 3 4 2 1
PARAM COL1 11 4 1
PARAM COL1 37 11 1 1400
UNIT G1 GPC BOTT/M1
PARAM G1 1 1 .75 1 .80 1.3 1
UNIT R1 RPORT OVHD BOTT FEED STM
FLOW FEED 1 75 150000 LB/HR
PRESS FEED 16.0 PSIA
TEMP FEED 201.4 F
C FLASH FEED PA
C VFRACTION FEED 0.
FLOW STM 2 2311.00 LB/HR
PRESS STM 114 PSIA
FLASH STM PA
VFRACTION STM 1.
ENDCASE
ENDJ

COMPONENTS AND PHYSICAL CONSTANTS:**VAPOR PRESSURE BY ANTOINE EQ****VAPOR FUGACITY BY IDEAL GAS EQ****LIQUID FUGACITY EQUAL TO VAPOR PRESSURE****ACTIVITY COEFFICIENTS BY CHIEN-NULL EQ****GAS SOLUBILITY BY PRAUSNITZ-SHAIR EQ****LIQUID ENTHALPY BY LARSEN EQ****2 COMPONENTS HAVE BEEN SPECIFIED:****1 BENZENE****2 WATER****1 NONIDEAL BINARY PAIRS HAVE BEEN SPECIFIED:****WATER****- BENZENE****BY VAN LAAR**

CASE 1A

4/8/93

M1 - MULPY - OUTPUT (STMA) IS 1.0260 TIMES FEED (STM)

COL1 - AFRAC - RIGOROUS DISTILLATION/ABSORPTION

FEED 1 IS FEED ON STAGE 4

FEED 2 IS STMA ON STAGE 1

BOTTOM PRODUCT IS BOTT

OVERHEAD VAPOR IS OVHD

STAGE	TEMP F	PRESSURE PSIA	LIQ FLOW LB-M/HR	VAP FLOW LB-M/HR
4	201.62	16.00	8329.38	3.67
3	203.49	16.01	8345.70	5.70
2	213.88	16.01	8437.91	22.02
1	216.54	16.02	8455.29	114.23

STAGE	LIQUID			VAPOR		
	GAL/MIN	LB/CUFT	LB/HR	CUFT/SEC	LB/CUFT	LB/HR
4	311.585	60.077	150133.	0.447	0.077	123.
3	312.389	60.036	150418.	0.696	0.072	182.
2	316.962	59.802	152024.	2.738	0.047	466.
1	317.912	59.740	152323.	14.263	0.040	2072.

LIQUID COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	0.0159	99.9841
3	0.0139	99.9861
2	0.0029	99.9971
1	0.0001	99.9999

VAPOR COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	25.8963	74.1037
3	23.0388	76.9612
2	5.2344	94.7656
1	0.2073	99.7927

CASE 1A

4/8/93

STREAM NAMES	OVHD	BOTT	FEED	STM
LBMOL/HR				
1 BENZENE	0.9505	0.0096	0.9601	0.0000
2 WATER	2.7200	8455.29	8326.39	128.282
TOTALS	3.6705	8455.29	8327.35	128.282
FRACTION VAPOR (MOL)	1.0000	0.0000	0.0000	1.0000
TEMP F	201.62	216.54	201.40	337.33
PRESS PSIA	16.000	16.020	16.000	114.000
ENTHALPY KBTU/HR	8.	-132532.	-132864.	332.
LIQ DENS LB/FT3	0.000	59.740	60.084	0.000
VAP DENS LB/FT3	0.0766	0.0000	0.0000	0.2491
LIQ CP BTU/LB-F	0.0000	1.0344	1.0295	0.0000
VAP CP BTU/LB-F	0.3749	0.0000	0.0000	0.4776
LB/HR				
1 BENZENE	74.2500	0.7500	75.0000	0.0000
2 WATER	49.0009	152321.9	149999.9	2311.00
TOTALS	123.251	152322.6	150074.9	2311.00

CASE 1A

4/8/93

STREAM NAMES	STMA
LBMOL/HR	
1 BENZENE	0.0000
2 WATER	131.614
TOTALS	131.614
FRACTION VAPOR (MOL)	1.0000
TEMP F	337.33
PRESS PSIA	114.000
ENTHALPY KBTU/HR	340.
LIQ DENS LB/FT3	0.000
VAP DENS LB/FT3	0.2491
LIQ CP BTU/LB-F	0.0000
VAP CP BTU/LB-F	0.4776
LB/HR	
1 BENZENE	0.0000
2 WATER	2371.03
TOTALS	2371.03

TITLE CASE 2A
PROPS 2 1 1 1 6 2 2
.RETR BENZENE WATER
.TYPE PAIR
.PROJ CED.ARMS.WBH6195
.RETR BENZENE/WATER/VAN-LAAR
UNIT M1 MULPY STM/STMA
PARAM M1 1 1.
UNIT COL1 AFRAC FEED STMA / BOTT 0 0 0 0 OVHD
PARAM COL1 1 209 194 14.0212 14.00 3 4 2 1
PARAM COL1 11 4 1
PARAM COL1 37 11 1 1400
UNIT G1 GPC BOTT/M1
PARAM G1 1 1 .75 1 .80 1.3 1
UNIT R1 RPORT OVHD BOTT FEED STM
FLOW FEED 1 75 150000 LB/HR
PRESS FEED 14.0 PSIA
TEMP FEED 194.7 F
C FLASH FEED PA
C VFRACTION FEED 0.
FLOW STM 2 2311.00 LB/HR
PRESS STM 114 PSIA
FLASH STM PA
VFRACTION STM 1.
ENDCASE
ENDJ

COMPONENTS AND PHYSICAL CONSTANTS:**VAPOR PRESSURE BY ANTOINE EQ****VAPOR FUGACITY BY IDEAL GAS EQ****LIQUID FUGACITY EQUAL TO VAPOR PRESSURE****ACTIVITY COEFFICIENTS BY CHIEN-NULL EQ****GAS SOLUBILITY BY PRAUSNITZ-SHAIR EQ****LIQUID ENTHALPY BY LARSEN EQ****2 COMPONENTS HAVE BEEN SPECIFIED:****1 BENZENE****2 WATER****1 NONIDEAL BINARY PAIRS HAVE BEEN SPECIFIED:****WATER****- BENZENE****BY VAN LAAR**

CASE 2A

4/8/93

M1 - MULPY - OUTPUT (STMA) IS 1.0128 TIMES FEED (STM)

COL1 - AFRAC - RIGOROUS DISTILLATION/ABSORPTION

FEED 1 IS FEED ON STAGE 4

FEED 2 IS STMA ON STAGE 1

BOTTOM PRODUCT IS BOTT

OVERHEAD VAPOR IS OVHD

STAGE	TEMP F	PRESSURE PSIA	LIQ FLOW LB-M/HR	VAP FLOW LB-M/HR
4	194.87	14.00	8328.91	3.60
3	196.43	14.01	8342.41	5.16
2	206.81	14.01	8433.90	18.66
1	209.78	14.02	8453.67	110.16

STAGE	LIQUID			VAPOR		
	GAL/MIN	LB/CUFT	LB/HR	CUFT/SEC	LB/CUFT	LB/HR
4	310.782	60.227	150120.	0.497	0.068	122.
3	311.442	60.194	150356.	0.713	0.065	167.
2	315.944	59.966	151952.	2.625	0.043	403.
1	317.007	59.899	152293.	15.570	0.036	1999.

LIQUID COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	0.0150	99.9850
3	0.0134	99.9866
2	0.0031	99.9969
1	0.0001	99.9999

VAPOR COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	26.3892	73.6108
3	23.9864	76.0136
2	5.9552	94.0448
1	0.2258	99.7742

CASE 2A

4/8/93

STREAM NAMES	OVHD	BOTT	FEED	STM
LBMOL/HR				
1 BENZENE	0.9505	0.0096	0.9601	0.0000
2 WATER	2.6515	8453.66	8326.39	128.282
TOTALS	3.6020	8453.67	8327.35	128.282
FRACTION VAPOR (MOL)	1.0000	0.0000	0.0000	1.0000
TEMP F	194.87	209.78	194.70	337.33
PRESS PSIA	14.000	14.021	14.000	114.000
ENTHALPY KBTU/HR	8.	-133570.	-133898.	332.
LIQ DENS LB/FT3	0.000	59.899	60.233	0.000
VAP DENS LB/FT3	0.0682	0.0000	0.0000	0.2491
LIQ CP BTU/LB-F	0.0000	1.0324	1.0274	0.0000
VAP CP BTU/LB-F	0.3716	0.0000	0.0000	0.4776
LB/HR				
1 BENZENE	74.2502	0.7498	75.0000	0.0000
2 WATER	47.7659	152292.6	149999.9	2311.00
TOTALS	122.016	152293.2	150074.9	2311.00

CASE 2A

4/8/93

STREAM NAMES	STMA
LBMOL/HR	
1 BENZENE	0.0000
2 WATER	129.919
TOTALS	129.919
FRACTION VAPOR (MOL)	1.0000
TEMP F	337.33
PRESS PSIA	114.000
ENTHALPY KBTU/HR	336.
LIQ DENS LB/FT3	0.000
VAP DENS LB/FT3	0.2491
LIQ CP BTU/LB-F	0.0000
VAP CP BTU/LB-F	0.4776
LB/HR	
1 BENZENE	0.0000
2 WATER	2340.49
TOTALS	2340.49

TITLE CASE 3A
PROPS 2 1 1 1 6 2 2
.RETR BENZENE WATER
.TYPE PAIR
.PROJ CED.ARMS.WBH6195
.RETR BENZENE/WATER/VAN-LAAR
UNIT M1 MULPY STM/STMA
PARAM M1 1 1.
UNIT COL1 AFRAC FEED STMA / BOTT 0 0 0 0 OVHD
PARAM COL1 1 201 187 12.0242 12.00 3 4 2 1
PARAM COL1 11 4 1
PARAM COL1 37 11 1 1400
UNIT G1 GPC BOTT/M1
PARAM G1 1 1 .75 1 .80 1.8 1
UNIT R1 RPORT OVHD BOTT FEED STM
FLOW FEED 1 75 150000 LB/HR
PRESS FEED 12.0 PSIA
TEMP FEED 187.0 F
C FLASH FEED PA
C VFRACTION FEED 0.
FLOW STM 2 1908.00 LB/HR
PRESS STM 114 PSIA
FLASH STM PA
VFRACTION STM 1.
ENDCASE
ENDJ

COMPONENTS AND PHYSICAL CONSTANTS:**VAPOR PRESSURE BY ANTOINE EQ****VAPOR FUGACITY BY IDEAL GAS EQ****LIQUID FUGACITY EQUAL TO VAPOR PRESSURE****ACTIVITY COEFFICIENTS BY CHIEN-NULL EQ****GAS SOLUBILITY BY PRAUSNITZ-SHAIR EQ****LIQUID ENTHALPY BY LARSEN EQ****2 COMPONENTS HAVE BEEN SPECIFIED:****1 BENZENE****2 WATER****1 NONIDEAL BINARY PAIRS HAVE BEEN SPECIFIED:****WATER****- BENZENE****BY VAN LAAR**

CASE 3A

4/8/93

M1 - MULPY - OUTPUT (STMA) IS 1.2212 TIMES FEED (STM)

COL1 - AFRAC - RIGOROUS DISTILLATION/ABSORPTION

FEED 1 IS FEED ON STAGE 4

FEED 2 IS STMA ON STAGE 1

BOTTOM PRODUCT IS BOTT

OVERHEAD VAPOR IS OVHD

STAGE	TEMP F	PRESSURE PSIA	LIQ FLOW LB-M/HR	VAP FLOW LB-M/HR
4	187.13	12.00	8328.49	3.50
3	188.39	12.01	8339.38	4.64
2	198.79	12.02	8430.27	15.53
1	202.18	12.02	8453.19	106.42

STAGE	LIQUID			VAPOR		
	GAL/MIN	LB/CUFT	LB/HR	CUFT/SEC	LB/CUFT	LB/HR
4	309.900	60.394	150109.	0.557	0.060	120.
3	310.427	60.368	150299.	0.740	0.058	154.
2	314.860	60.147	151888.	2.519	0.038	344.
1	316.072	60.073	152285.	17.356	0.031	1933.

LIQUID COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	0.0142	99.9858
3	0.0130	99.9870
2	0.0033	99.9967
1	0.0001	99.9999

VAPOR COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	27.1787	72.8213
3	25.2176	74.7824
2	6.9167	93.0833
1	0.2485	99.7515

CASE 3A

4/8/93

STREAM NAMES	OVHD	BOTT	FEED	STM
LBMOL/HR				
1 BENZENE	0.9505	0.0096	0.9601	0.0000
2 WATER	2.5468	8453.18	8326.39	105.912
TOTALS	3.4974	8453.19	8327.35	105.912
FRACTION VAPOR (MOL)	1.0000	0.0000	0.0000	1.0000
TEMP F	187.13	202.18	187.00	337.33
PRESS PSIA	12.000	12.024	12.000	114.000
ENTHALPY KBTU/HR	7.	-134757.	-135084.	274.
LIQ DENS LB/FT3	0.000	60.073	60.398	0.000
VAP DENS LB/FT3	0.0599	0.0000	0.0000	0.2491
LIQ CP BTU/LB-F	0.0000	1.0300	1.0249	0.0000
VAP CP BTU/LB-F	0.3673	0.0000	0.0000	0.4776
LB/HR				
1 BENZENE	74.2500	0.7500	75.0000	0.0000
2 WATER	45.8810	152284.0	149999.9	1908.00
TOTALS	120.131	152284.7	150074.9	1908.00

CASE 3A

4/8/93

STREAM NAMES	STMA
LBMOL/HR	
1 BENZENE	0.0000
2 WATER	129.335
TOTALS	129.335
FRACTION VAPOR (MOL)	1.0000
TEMP F	337.33
PRESS PSIA	114.000
ENTHALPY KBTU/HR	334.
LIQ DENS LB/FT3	0.000
VAP DENS LB/FT3	0.2491
LIQ CP BTU/LB-F	0.0000
VAP CP BTU/LB-F	0.4776
LB/HR	
1 BENZENE	0.0000
2 WATER	2329.98
TOTALS	2329.98

TITLE CASE 4A
PROPS 2 1 1 1 6 2 2
.RETR BENZENE WATER
.TYPE PAIR
.PROJ CED.ARMS.WBH6195
.RETR BENZENE/WATER/VAN-LAAR
UNIT M1 MULPY STM/STMA
PARAM M1 1 1.
UNIT COL1 AFRAC FEED STMA / BOTT 0 0 0 0 OVHD
PARAM COL1 1 193 178 10.0288 10.00 3 4 2 1
PARAM COL1 11 4 1
PARAM COL1 37 11 1 1400
UNIT G1 GPC BOTT/M1
PARAM G1 1 1 .75 1 .80 1.3 1
UNIT R1 RPORT OVHD BOTT FEED STM
FLOW FEED 1 75 150000 LB/HR
PRESS FEED 10.0 PSIA
TEMP FEED 178.4 F
C FLASH FEED PA
C VFRACTION FEED 0.
FLOW STM 2 1908.00 LB/HR
PRESS STM 114 PSIA
FLASH STM PA
VFRACTION STM 1.
ENDCASE
ENDJ

COMPONENTS AND PHYSICAL CONSTANTS:**VAPOR PRESSURE BY ANTOINE EQ****VAPOR FUGACITY BY IDEAL GAS EQ****LIQUID FUGACITY EQUAL TO VAPOR PRESSURE****ACTIVITY COEFFICIENTS BY CHIEN-NULL EQ****GAS SOLUBILITY BY PRAUSNITZ-SHAIR EQ****LIQUID ENTHALPY BY LARSEN EQ****2 COMPONENTS HAVE BEEN SPECIFIED:****1 BENZENE****2 WATER****1 NONIDEAL BINARY PAIRS HAVE BEEN SPECIFIED:****WATER****- BENZENE****BY VAN LAAR**

CASE 4A

4/8/93

M1 - MULPY - OUTPUT (STMA) IS 1.1963 TIMES FEED (STM)

COL1 - AFRAC - RIGOROUS DISTILLATION/ABSORPTION

FEED 1 IS FEED ON STAGE 4

FEED 2 IS STMA ON STAGE 1

BOTTOM PRODUCT IS BOTT

OVERHEAD VAPOR IS OVHD

STAGE	TEMP F	PRESSURE PSIA	LIQ FLOW LB-M/HR	VAP FLOW LB-M/HR
4	178.48	10.00	8328.04	3.43
3	179.46	10.01	8336.47	4.12
2	189.58	10.02	8424.12	12.55
1	193.44	10.03	8450.62	100.20

STAGE	LIQUID			VAPOR		
	GAL/MIN	LB/CUFT	LB/HR	CUFT/SEC	LB/CUFT	LB/HR
4	308.952	60.574	150095.	0.647	0.051	119.
3	309.356	60.554	150243.	0.778	0.050	139.
2	313.587	60.347	151778.	2.411	0.033	287.
1	314.963	60.266	152238.	19.350	0.026	1822.

LIQUID COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	0.0131	99.9869
3	0.0122	99.9878
2	0.0034	99.9966
1	0.0001	99.9999

VAPOR COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	27.7020	72.2980
3	26.1687	73.8313
2	8.0455	91.9545
1	0.2774	99.7226

CASE 4A

4/8/93

STREAM NAMES	OVHD	BOTT	FEED	STM
LBMOL/HR				
1 BENZENE	0.9505	0.0096	0.9601	0.0000
2 WATER	2.4807	8450.61	8326.39	105.912
TOTALS	3.4312	8450.62	8327.35	105.912
FRACTION VAPOR (MOL)	1.0000	0.0000	0.0000	1.0000
TEMP F	178.48	193.44	178.40	337.33
PRESS PSIA	10.000	10.029	10.000	114.000
ENTHALPY KBTU/HR	7.	-136084.	-136405.	274.
LIQ DENS LB/FT3	0.000	60.266	60.576	0.000
VAP DENS LB/FT3	0.0510	0.0000	0.0000	0.2491
LIQ CP BTU/LB-F	0.0000	1.0273	1.0220	0.0000
VAP CP BTU/LB-F	0.3632	0.0000	0.0000	0.4776
LB/HR				
1 BENZENE	74.2492	0.7507	75.0000	0.0000
2 WATER	44.6903	152237.7	149999.9	1908.00
TOTALS	118.939	152238.4	150074.9	1908.00

CASE 4A

4/8/93

STREAM NAMES	STMA
LBMOL/HR	
1 BENZENE	0.0000
2 WATER	126.701
TOTALS	126.701
FRACTION VAPOR (MOL)	1.0000
TEMP F	337.33
PRESS PSIA	114.000
ENTHALPY KBTU/HR	327.
LIQ DENS LB/FT ³	0.000
VAP DENS LB/FT ³	0.2491
LIQ CP BTU/LB-F	0.0000
VAP CP BTU/LB-F	0.4776
LB/HR	
1 BENZENE	0.0000
2 WATER	2282.51
TOTALS	2282.51

TITLE CASE 5A
PROPS 2 1 1 1 6 2 2
.RETR BENZENE WATER
.TYPE PAIR
.PROJ CED.ARMS.WBH6195
.RETR BENZENE/WATER/VAN-LAAR
UNIT M1 MULPY STM/STMA
PARAM M1 1 1.
UNIT COL1 AFRAC FEED STMA / BOTT 0 0 0 0 OVHD
PARAM COL1 1 180 165 7.5375 7.5 3 4 2 1
PARAM COL1 11 4 1
PARAM COL1 37 11 1 1400
UNIT G1 GPC BOTT/M1
PARAM G1 1 1 .75 1 .30 2.3 1
UNIT R1 RPORT OVHD BOTT FEED STM
FLOW FEED 1 75 150000 LB/HR
PRESS FEED 7.5 PSIA
TEMP FEED 165.2 F
C FLASH FEED PA
C VFRACTION FEED 0.
FLOW STM 2 2300.00 LB/HR
PRESS STM 114 PSIA
FLASH STM PA
VFRACTION STM 1.
ENDCASE
ENDJ

COMPONENTS AND PHYSICAL CONSTANTS:**VAPOR PRESSURE BY ANTOINE EQ****VAPOR FUGACITY BY IDEAL GAS EQ****LIQUID FUGACITY EQUAL TO VAPOR PRESSURE****ACTIVITY COEFFICIENTS BY CHIEN-NULL EQ****GAS SOLUBILITY BY PRAUSNITZ-SHAIR EQ****LIQUID ENTHALPY BY LARSEN EQ****2 COMPONENTS HAVE BEEN SPECIFIED:****1 BENZENE****2 WATER****1 NONIDEAL BINARY PAIRS HAVE BEEN SPECIFIED:****WATER****- BENZENE****BY VAN LAAR**

CASE 5A

4/8/93

M1 - MULPY - OUTPUT (STMA) IS 0.97232 TIMES FEED (STM)

COL1 - AFRAC - RIGOROUS DISTILLATION/ABSORPTION

FEED 1 IS FEED ON STAGE 4

FEED 2 IS STMA ON STAGE 1

BOTTOM PRODUCT IS BOTT

OVERHEAD VAPOR IS OVHD

STAGE	TEMP F	PRESSURE PSIA	LIQ FLOW LB-M/HR	VAP FLOW LB-M/HR
4	165.22	7.50	8327.52	3.31
3	165.90	7.51	8333.24	3.48
2	175.53	7.52	8415.54	9.20
1	180.20	7.54	8448.18	91.49

STAGE	LIQUID			VAPOR		
	GAL/MIN	LB/CUFT	LB/HR	CUFT/SEC	LB/CUFT	LB/HR
4	307.587	60.836	150079.	0.816	0.040	117.
3	307.858	60.823	150180.	0.858	0.039	121.
2	311.769	60.638	151624.	2.304	0.027	221.
1	313.421	60.545	152195.	23.057	0.020	1666.

LIQUID COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	0.0117	99.9883
3	0.0112	99.9888
2	0.0037	99.9963
1	0.0001	99.9999

VAPOR COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	28.7354	71.2646
3	27.7189	72.2811
2	10.0498	89.9502
1	0.3267	99.6733

CASE 5A

4/8/93

STREAM NAMES	OVHD	BOTT	FEED	STM
LBMOL/HR				
1 BENZENE	0.9505	0.0096	0.9601	0.0000
2 WATER	2.3573	8448.17	8326.39	127.671
TOTALS	3.3078	8448.18	8327.35	127.671
FRACTION VAPOR (MOL)	1.0000	0.0000	0.0000	1.0000
TEMP F	165.22	180.20	165.20	337.33
PRESS PSIA	7.500	7.537	7.500	114.000
ENTHALPY KBTU/HR	6.	-138110.	-138425.	330.
LIQ DENS LB/FT ³	0.000	60.545	60.836	0.000
VAP DENS LB/FT ³	0.0397	0.0000	0.0000	0.2491
LIQ CP BTU/LB-F	0.0000	1.0229	1.0173	0.0000
VAP CP BTU/LB-F	0.3564	0.0000	0.0000	0.4776
LB/HR				
1 BENZENE	74.2489	0.7510	75.0000	0.0000
2 WATER	42.4670	152193.7	149999.9	2300.00
TOTALS	116.716	152194.4	150074.9	2300.00

CASE 5A

4/8/93

STREAM NAMES	STMA
LBMOL/HR	
1 BENZENE	0.0000
2 WATER	124.137
TOTALS	124.137
FRACTION VAPOR (MOL)	1.0000
TEMP F	337.33
PRESS PSIA	114.000
ENTHALPY KBTU/HR	321.
LIQ DENS LB/FT3	0.000
VAP DENS LB/FT3	0.2491
LIQ CP BTU/LB-F	0.0000
VAP CP BTU/LB-F	0.4776
LB/HR	
1 BENZENE	0.0000
2 WATER	2236.32
TOTALS	2236.32

TITLE CASE 6
PROPS 2 1 1 1 6 2 2
.RETR BENZENE WATER
.TYPE PAIR
.PROJ CED.ARMS.WBH6195
.RETR BENZENE/WATER/VAN-LAAR
UNIT M1 MULPY STM/STMA
PARAM M1 1 1.
UNIT COL1 AFRAC FEED STMA / BOTT 0 0 0 0 OVHD
PARAM COL1 1 162 147 5.0510 5.000 3 4 2 1
PARAM COL1 11 4 1
PARAM COL1 37 11 1 1400
UNIT G1 GPC BOTT/M1
PARAM G1 1 1 .75 1 .70 1.3 1
UNIT R1 RPORT OVHD BOTT FEED STM
FLOW FEED 1 75 150000 LB/HR
PRESS FEED 5.0 PSIA
FLASH FEED PA
VFRACTION FEED 0.000034361
FLOW STM 2 2300.00 LB/HR
PRESS STM 114 PSIA
FLASH STM PA
VFRACTION STM 1.
ENDCASE
ENDJ

COMPONENTS AND PHYSICAL CONSTANTS:**VAPOR PRESSURE BY ANTOINE EQ****VAPOR FUGACITY BY IDEAL GAS EQ****LIQUID FUGACITY EQUAL TO VAPOR PRESSURE****ACTIVITY COEFFICIENTS BY CHIEN-NULL EQ****GAS SOLUBILITY BY PRAUSNITZ-SHAIR EQ****LIQUID ENTHALPY BY LARSEN EQ****2 COMPONENTS HAVE BEEN SPECIFIED:****1 BENZENE****2 WATER****1 NONIDEAL BINARY PAIRS HAVE BEEN SPECIFIED:****WATER****- BENZENE****BY VAN LAAR**

CASE 6

4/8/93

M1 - MULPY - OUTPUT (STMA) IS 0.97943 TIMES FEED (STM)

COL1 - AFRAC - RIGOROUS DISTILLATION/ABSORPTION

FEED 1 IS FEED ON STAGE 4

FEED 2 IS STMA ON STAGE 1

BOTTOM PRODUCT IS BOTT

OVERHEAD VAPOR IS OVHD

STAGE	TEMP F	PRESSURE PSIA	LIQ FLOW LB-M/HR	VAP FLOW LB-M/HR
4	147.10	5.00	8327.11	3.07
3	147.52	5.02	8330.56	2.83
2	156.58	5.03	8406.57	6.28
1	162.63	5.05	8449.32	82.30

STAGE	LIQUID			VAPOR		
	GAL/MIN	LB/CUFT	LB/HR	CUFT/SEC	LB/CUFT	LB/HR
4	305.891	61.168	150065.	1.105	0.028	112.
3	306.052	61.160	150126.	1.015	0.028	103.
2	309.587	61.001	151465.	2.283	0.020	164.
1	311.685	60.891	152215.	30.134	0.014	1503.

LIQUID COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	0.0105	99.9895
3	0.0103	99.9897
2	0.0041	99.9959
1	0.0001	99.9999

VAPOR COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	30.9570	69.0430
3	30.4724	69.5276
2	13.4834	86.5166
1	0.4037	99.5963

CASE 6

4/8/93

STREAM NAMES	OVHD	BOTT	FEED	STM
LBMOL/HR				
1 BENZENE	0.9505	0.0096	0.9601	0.0000
2 WATER	2.1200	8449.31	8326.39	127.671
TOTALS	3.0705	8449.32	8327.35	127.671
FRACTION VAPOR (MOL)	1.0000	0.0000	0.0000	1.0000
TEMP F	147.10	162.63	147.10	337.33
PRESS PSIA	5.000	5.051	5.000	114.000
ENTHALPY KBTU/HR	5.	-140856.	-141174.	330.
LIQ DENS LB/FT3	0.000	60.891	61.167	0.000
VAP DENS LB/FT3	0.0283	0.0000	0.0000	0.2491
LIQ CP BTU/LB-F	0.0000	1.0167	1.0105	0.0000
VAP CP BTU/LB-F	0.3457	0.0000	0.0000	0.4776
LB/HR				
1 BENZENE	74.2501	0.7499	75.0000	0.0000
2 WATER	38.1911	152214.3	149999.9	2300.00
TOTALS	112.441	152215.0	150074.9	2300.00

CASE 6

4/8/93

STREAM NAMES	STMA
LBMOL/HR	
1 BENZENE	0.0000
2 WATER	125.045
TOTALS	125.045
FRACTION VAPOR (MOL)	1.0000
TEMP F	337.33
PRESS PSIA	114.000
ENTHALPY KBTU/HR	323.
LIQ DENS LB/FT ³	0.000
VAP DENS LB/FT ³	0.2491
LIQ CP BTU/LB-F	0.0000
VAP CP BTU/LB-F	0.4776
LB/HR	
1 BENZENE	0.0000
2 WATER	2252.68
TOTALS	2252.68

TITLE CASE 7
PROPS 2 1 1 1 6 2 2
.RETR BENZENE WATER
.TYPE PAIR
.PROJ CED.ARMS.WBH6195
.RETR BENZENE/WATER/VAN-LAAR
UNIT M1 MULPY STM/STMA
PARAM M1 1 1.
UNIT COL1 AFRAC FEED STMA / BOTT 0 0 0 0 OVHD
PARAM COL1 1 127 113 2.1100 2.000 3 4 2 1
PARAM COL1 11 4 1
PARAM COL1 37 11 1 1400
UNIT G1 GPC BOTT/M1
PARAM G1 1 1 .75 1 .70 1.3 1
UNIT R1 RPORT OVHD BOTT FEED STM
FLOW FEED 1 75 150000 LB/HR
PRESS FEED 2.0 PSIA
FLASH FEED PA
VFRACTION FEED 0.00014402
FLOW STM 2 2300.00 LB/HR
PRESS STM 114 PSIA
FLASH STM PA
VFRACTION STM 1.
ENDCASE
ENDJ

COMPONENTS AND PHYSICAL CONSTANTS:

VAPOR PRESSURE BY ANTOINE EQ

VAPOR FUGACITY BY IDEAL GAS EQ

LIQUID FUGACITY EQUAL TO VAPOR PRESSURE

ACTIVITY COEFFICIENTS BY CHIEN-NULL EQ

GAS SOLUBILITY BY PRAUSNITZ-SHAIR EQ

LIQUID ENTHALPY BY LARSEN EQ

2 COMPONENTS HAVE BEEN SPECIFIED:

1 BENZENE

2 WATER

1 NONIDEAL BINARY PAIRS HAVE BEEN SPECIFIED:

WATER - BENZENE BY VAN LAAR

CASE 7

4/8/93

M1 - MULPY - OUTPUT (STMA) IS 0.90798 TIMES FEED (STM)

COL1 - AFRAC - RIGOROUS DISTILLATION/ABSORPTION

FEED 1 IS FEED ON STAGE 4

FEED 2 IS STMA ON STAGE 1

BOTTOM PRODUCT IS BOTT

OVERHEAD VAPOR IS OVHD

STAGE	TEMP F	PRESSURE PSIA	LIQ FLOW LB-M/HR	VAP FLOW LB-M/HR
4	112.67	2.00	8326.10	3.06
3	112.83	2.04	8327.35	1.80
2	119.35	2.07	8380.07	3.06
1	127.85	2.11	8440.22	55.78

STAGE	LIQUID			VAPOR		
	GAL/MIN	LB/CUFT	LB/HR	CUFT/SEC	LB/CUFT	LB/HR
4	303.100	61.716	150030.	2.601	0.012	112.
3	303.161	61.714	150054.	1.508	0.012	67.
2	305.513	61.620	150988.	2.538	0.010	91.
1	308.307	61.491	152051.	46.228	0.006	1025.

LIQUID COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	0.0071	99.9929
3	0.0074	99.9926
2	0.0042	99.9958
1	0.0001	99.9999

VAPOR COMPOSITIONS, MOLE PERCENT

STAGE	COMP 1	COMP 2
4	31.1062	68.8938
3	32.0465	67.9535
2	19.8124	80.1876
1	0.6085	99.3915

CASE 7

4/8/93

STREAM NAMES	OVHD	BOTT	FEED	STM
LBMOL/HR				
1 BENZENE	0.9505	0.0096	0.9601	0.0000
2 WATER	2.1052	8440.21	8326.39	127.671
TOTALS	3.0558	8440.22	8327.35	127.671
FRACTION VAPOR (MOL)	1.0000	0.0000	0.0001	1.0000
TEMP F	112.67	127.85	112.68	337.33
PRESS PSIA	2.000	2.110	2.000	114.000
ENTHALPY KBTU/HR	4.	-146046.	-146342.	330.
LIQ DENS LB/FT3	0.000	61.491	0.000	0.000
VAP DENS LB/FT3	0.0120	0.0000	0.0000	0.2491
LIQ CP BTU/LB-F	0.0000	1.0029	0.0000	0.0000
VAP CP BTU/LB-F	0.3318	0.0000	0.0000	0.4776
LB/HR				
1 BENZENE	74.2503	0.7497	75.0000	0.0000
2 WATER	37.9259	152050.3	149999.9	2300.00
TOTALS	112.176	152051.0	150074.9	2300.00

CASE 7

4/8/93

STREAM NAMES	STMA
LBMOL/HR	
1 BENZENE	0.0000
2 WATER	115.923
TOTALS	115.923
FRACTION VAPOR (MOL)	1.0000
TEMP F	337.33
PRESS PSIA	114.000
ENTHALPY KBTU/HR	300.
LIQ DENS LB/FT3	0.000
VAP DENS LB/FT3	0.2491
LIQ CP BTU/LB-F	0.0000
VAP CP BTU/LB-F	0.4776
LB/HR	
1 BENZENE	0.0000
2 WATER	2088.35
TOTALS	2088.35

Hypotech's Process Simulator HYSIM - Licensed to Monsanto Company
 Date 93/04/12 Version 386|C2.10 Case Name EPAHY.SIM
 Time 21:26:07 Prop Pkg Chien-Null-Id

PROCESS FLOWSHEET SPECIFICATIONS

Default Units: FIELD
 Equilibrium Package: Chien-Null-Ideal
 Enthalpy Package: Cavett

Stream: FEED

CONDITIONS		COMPOSITION	
Temperature	201.4000 F	Benzene	0.0001
Pressure	16.0000 psia	H2O	0.9999
Flow	8327.3501 lbmole/hr		

Stream: stma

CONDITIONS		COMPOSITION	
Vapour_Frac	1.0000	Benzene	0.0000
Pressure	114.0000 psia	H2O	1.0000
Mass_Flow	2203.2501 lb/hr		

Energy Stream: QDUM

CONDITIONS		COMPOSITION	
Energy_Flow	---	Btu/hr	

Hyprotech's Process Simulator HYSIM - Licensed to Monsanto Company
 Date 93/04/12 Version 386|C2.10 Case Name EPAHY.SIM
 Time 21:26:07 Prop Pkg Chien-Null-Id

A=dimensionless, B=deg K, C=dimensionless or 1/deg K page - 1

Component i	ID							
Benzene	17							
Component	Opt	Aij	Aji	Bij	Bji	Cij	Cji	
H2O	vanL	23.592	-6.006	-2105.029	3114.435	-0.029	0.002	

Component i	ID							
H2O	19							
Component	Opt	Aij	Aji	Bij	Bji	Cij	Cji	
Benzene	vanL	-6.006	23.592	3114.435	-2105.029	0.002	-0.029	

Hypotech's Process Simulator HYSIM - Licensed to Monsanto Company
Date 93/04/12 Version 386|C2.10 Case Name EPAHY.SIM
Time 21:26:07 Prop Pkg Chien-Null-Id

Unit Operations

Colu	str: FEED	stma	-OVHD	-BOTT
Frac	frac: BOTT	QDUM	-BZ	-WAT
Adju	stra: Adj Var: Mass_Flow of stream stma Dep Var: Cmp_Mass_Flo Benzene in stream BOTT Target: 0.75 lb/hr Tol: 0.0050 lb/hr Step: 0.2500 lb/hr Min: 2030.0000 lb/hr Max: 2500.0000 lb/hr Type: Secant			

Hyprotech's Process Simulator HYSIM - Licensed to Monsanto Company
Date 93/04/12 Version 386|C2.10 Case Name EPAHY.SIM
Time 21:26:07 Prop Pkg Chien-Null-Id Column Name str

***** Column Input *****

Number of Ideal Stages 4
Stage 1 Pressure 16.000 psia
Stage 4 Pressure 16.020 psia
Stage 1 Temperature Estimate 201.000 F
Stage 4 Temperature Estimate 216.000 F
Feed stream FEED enters on stage 1
Feed stream stma enters on stage 4
Overhead Vapour Estimated Flow 3.0000 lbmole/hr
Overhead vapour product goes to stream OVHD
Bottom liquid product goes to stream BOTT

***** Specifications *****

Stream Description	FEED	stma	OVHD	BOTT
Vapour frac.	0.0000	1.0000*	1.0000	0.0000
Temperature F	201.4000*	337.4501	201.5037	216.2550
Pressure psia	16.0000*	114.0000*	16.0000	16.0203
Molar Flow lbmole/hr	8327.3501*	122.3002	3.6995	8445.9507
Mass Flow lb/hr	150075.7509	2203.2501*	123.7645	152155.2399
LiqVol Flow ft3/hr	2409.0173	35.3643	2.1429	2442.2385
Enthalpy Btu/hr	-1.05321E+08	779871.0659	22895.1540	-1.04564E+08
Density lb/ft3	59.4807	0.2401	0.0754	59.0525
Mole Wt.	18.0220	18.0151	33.4540	18.0152
Spec. Heat Btu/lbmole-F	18.0561	8.2937	12.3621	18.0744
Therm Cond Btu/hr-ft-F	0.3927	0.0181	0.0119	0.3951
Viscosity cP	0.2985	0.0112	0.0096	0.2651
Z Factor	0.0007	1.0000	1.0000	0.0007
Sur Tension dyne/cm	59.7122	---	---	58.1560
Std Density lb/ft3	63.3253	---	---	63.3288
Benzene lb/hr	74.9934*	0.0000*	74.2393	0.7541
H2O lb/hr	150000.7555*	2203.2501*	49.5252	152154.4782
Total: lb/hr	150075.7509	2203.2501*	123.7645	152155.2399

Stream Description	QDUM	BZ	WAT
Vapour frac.	2.0000*	---	---
Temperature F	0.0000*	---	---
Pressure psia	0.0000*	---	---
Molar Flow lbmole/hr	0.0000*	0.0097	8445.9410
Mass Flow lb/hr	0.0000*	0.7541	152154.4821
LiqVol Flow ft3/hr	0.0000*	0.0137	2442.2248
Enthalpy Btu/hr	---	---	---
Density lb/ft3	0.0000	---	---
Mole Wt.	0.0000	78.1100	18.0151
Spec. Heat Btu/lbmole-F	0.0000	---	---
Therm Cond Btu/hr-ft-F	---	---	---
Viscosity cP	---	---	---
Z Factor	---	---	---
Sur Tension dyne/cm	---	---	---
Std Density lb/ft3	---	---	---
Benzene lb/hr	0.0000*	0.7541	0.0000
H2O lb/hr	0.0000*	0.0000	152154.4760
Total: lb/hr	0.0000*	0.7541	152154.4821

MAR-25-1993 15:31 FROM EXXON SAFETY-ENV ENGR

TO

B-13146947049 P.001/026

FACSIMILE TRANSMITTAL

Date: 3/25Normal X Urgent Page 1 of 2 6

TO:

Name

Company / Location

Fax Number

JERRY Schroy Mensauto 314-694-7049

FROM:

B C DAVIS

EXXON CHEMICAL COMPANY
Basic Chemicals Technology, Baytown, TX
Safety / Environmental Engineering
FAX: (713) 425-2802

For problems with reception call Patti Pequeno (713) 425-5823.

MESSAGE:

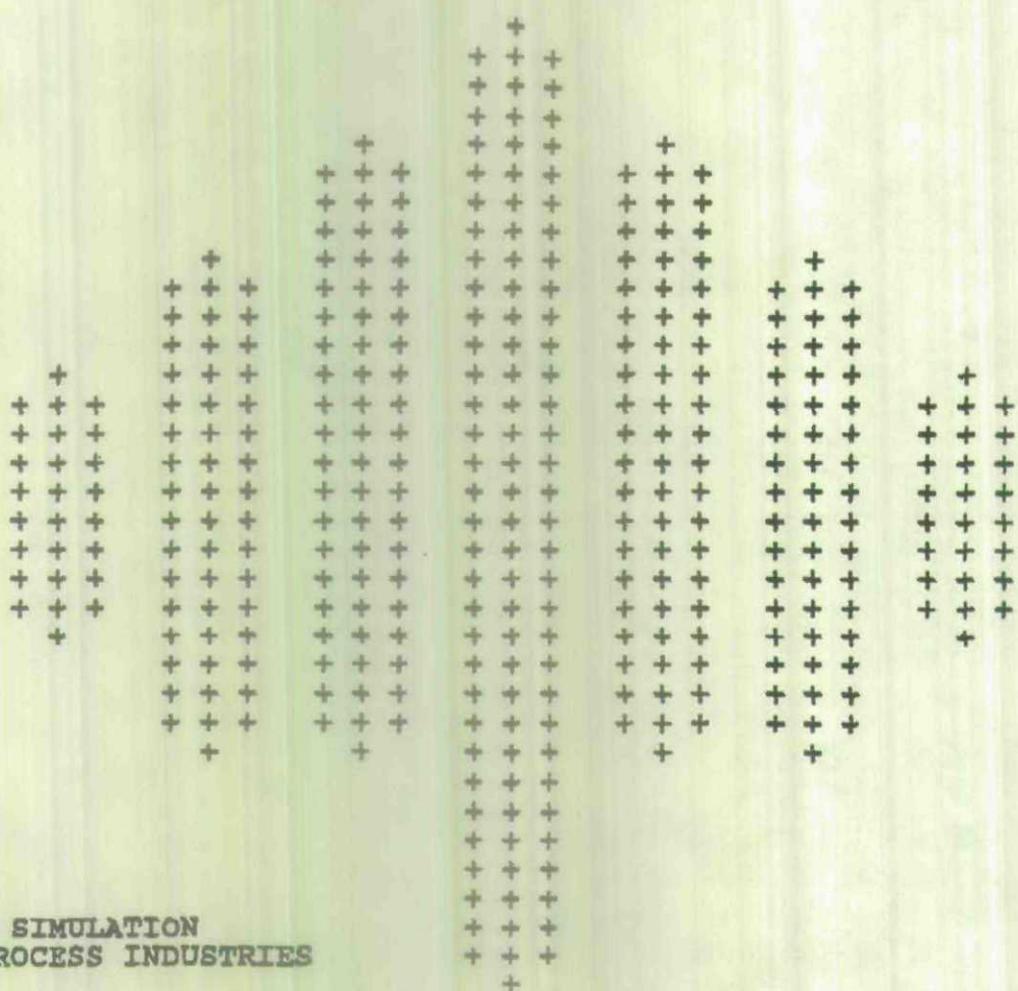
COPIES OF ASPEN RUNS SO FAR.

Bruce

MAR-25-1993 15:31 FROM EXXON SAFETY-ENV ENGR

TO

B-13146947049 P.002/026



ASPENTECH

FLOWSHEET SIMULATION
FOR THE PROCESS INDUSTRIES

AAAAA	SSSSS	PPPPP	EEEEEE	NN	N	PPPPP	L	U	U	SSSSS
A A	S	P P	E	N N	N	P P	L	U	U	S
AAAAAA	SSSSS	PPPPP	EEEEEE	N	N N	PPPPP	L	U	U	SSSSS
A A	S	P	E	N	NN	P	L	U	U	S
A A	SSSSS	P	EEEEEE	N	N	P	LLLLL	UUUUU	UUUUU	SSSSS

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251 VASSAR STREET
CAMBRIDGE, MASSACHUSETTS 02139
617-497-9010

HOTLINE:
U.S.A. 617-497-9010
EUROPE 31-70-3541051

VERSION: DOS-386
RELEASE: 8.4-1
INSTALLATION: AWDHOU

JULY 4, 1991
THURSDAY
3:13:38 P.M.

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*** INPUT ECHO(ES) ***

>CURRENT RUN

807, MORPHREE RAY
EFF. 16 STAGES?

MAR-25-1993 15:32 FROM EXXON SAFETY-ENU ENGR TO 8-13146947049 P.003/026

ORIGINAL RUN
3:13:38 P.M.
INPUT FILE: RUN1.inp
OUTPUT PDF: RUN1 VERSION: 1
LOCATED IN: C:\ASPEN\RUN1
PDF SIZE: FILE (PSIZE)=99999 RECORDS. IN-CORE = 400 RECORDS.

JULY 4, 1991
THURSDAY

```

1   ;
2   ;Input file created by ModelManager Rel. 3.2-1 on Thu Jul 4 15:12:20 1
3   ;Directory C:\ASPEN Runid RUN1
4   ;
5
6   SUMMARY MN
7
8   IN-UNITS ENG
9
10  DEF-STREAMS CONVEN ALL
11
12  TITLE "CHEMICAL MANUFACTURRS ASSOC. SIMULATION STUDIES"
13
14  DATABANKS ASPENPCD / DIPPRPCD
15
16  PROP-SOURCES ASPENPCD / DIPPRPCD
17
18  COMPONENTS
19    C6H6 C6H6 C6H6 /
20    H2O H2O H2O
21
22  HENRY-COMPS LIST1 C6H6 H2O
23
24  FLOWSHEET
25    BLOCK B1 IN=3 4 OUT=1 2
26
27  PROPERTIES SYSOP11A HENRY-COMPS=LIST1
28
29  PROP-DATA
30    IN-UNITS SI
31    PROP-LIST GMUQB
32    BPVAL C6H6 H2O -879.4033
33    BPVAL H2O C6H6 -363.7491
34
35  PROP-DATA
36    IN-UNITS SI
37    PROP-LIST GMUQA
38    BPVAL C6H6 H2O -.7254485E-01
39    BPVAL H2O C6H6 .8297351E-02
40
41  PROP-DATA
42    IN-UNITS SI
43    PROP-LIST HENRY
44    BPVAL C6H6 H2O 73.157 -6276 -8.4443 6.26E-06 278.68 &
45    562.16
46
47  STREAM 3
48    SUBSTREAM MIXED TEMP=203 PRES=16
49    MASS-FLOW C6H6 75 / H2O 150000
50
51  STREAM 4
52    SUBSTREAM MIXED PRES=100 VFRAC=1
53    MASS-FLOW H2O 14400
54
55  BLOCK B1 RADFRAC
56    PARAM NSTAGE=10 EFF=MURPHREE
57    FEEDS 3 1 ON-STAGE / 4 10 ON-STAGE
58

```

MAR-25-1993 15:32 FROM EXXON SAFETY-ENU ENGR TO 8-13146947049 P.004/026

59 PRODUCTS 1 1 V / 2 10 L
 60 P-SPEC 1 16
 61 COL-SPECS Q1=0 QN=0 DP-COL=3 MASS-RDV=1
 62 STAGE-EFF 1 .8 / 10 .8
 63 T-EST 1 215 / 10 226

64
 65 STREAM-REPOR MOLEFLOW MASSFLOW
 66

67 PROPERTY-REP PARAMS PCES PROP-DATA

68 ;
 69 ;
 70 ;
 71 ;
 72 ;

*** INPUT TRANSLATOR MESSAGES ***

THIS VERSION OF ASPEN PLUS LICENSED TO AWD TECHNOLOGIES, INC.

*** FLOWSHEET ANALYSIS MESSAGES ***

FLOWSHEET CONNECTIVITY BY STREAMS

STREAM	SOURCE	DEST	STREAM	SOURCE	DEST
4	----	B1	3	----	B1
1	B1	----	2	B1	----

FLOWSHEET CONNECTIVITY BY BLOCKS

BLOCK	INLETS	OUTLETS
B1	3 4	1 2

COMPUTATION ORDER FOR THE FLOWSHEET IS:

31

INFORMATION DURING PROGRAM GENERATION
 PP COMMON MISSING, OR TOO SMALL: GMUQR (OLDMOD.6)
 NEW LENGTH = 2 OLD LENGTH = 0
 THEREFORE, THE MODULE CANNOT BE USED
 MODULE RUN1 WILL BE GENERATED 07/04/91 15:13:38:27
 LOCATED IN:C:\ASPEN\RUN1
 IN-CORE-PLEX SIZE = 53 RECORDS, WORK SIZE = 51110 INTEGER WORDS

NO ERRORS OR WARNINGS GENERATED
 SIMULATION PROGRAM MAY BE EXECUTED

 ASPEN PLUS INPUT TRANSLATOR ENDS EXECUTION *

** CALCULATION TRACE **

HEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES

IMULATION CALCULATIONS BEGIN

ENTHALPY CALCULATION FOR INLET STREAM 3 OF BLOCK B1
 KODE = 2 NTRIAL = 3 T = 368.1 P = 0.1103E+06 V = 0.0000E+00

ENTHALPY CALCULATION FOR INLET STREAM 4 OF BLOCK B1
 KODE = 3 NTRIAL = 3 T = 437.7 P = 0.6895E+06 V = 1.000

UOS BLOCK B1 MODEL: RADFRAC

MAR-25-1993 15:32 FROM EXXON SAFETY-ENU ENGR

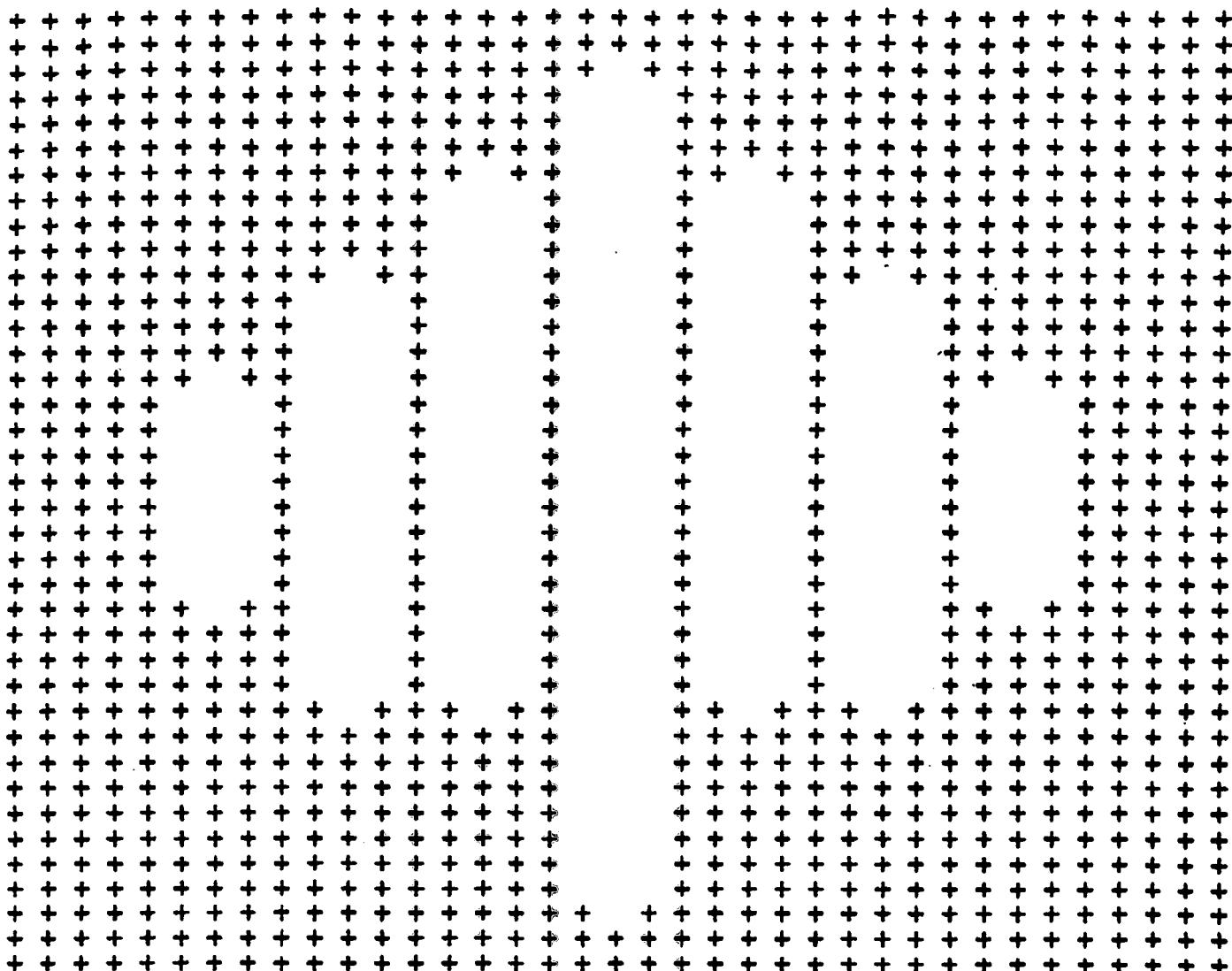
TO

B-13146947049

P.005/026

***** ITERATION HISTORY ********** OUTSIDE LOOP *** 1 1 1 0.74287E-05****SIMULATION CALCULATIONS COMPLETED****PDF UPDATED****REPORT WRITER ENTERED****REPORT GENERATED****NO ERRORS OR WARNINGS GENERATED*********
* ASPEN PLUS SIMULATION PROGRAM ENDS EXECUTION *

MAR-25-1993 15:32 FROM EXXON SAFETY-ENU ENGR TO B-13146947049 P.006/026



AAAAA	SSSSS	PPPPP	EEEEE	NN	N	PPPPP	L	U	U	SSSSS
A A	S	P	E	N N	N	P	L	U	U	S
AAAAA	SSSSS	PPPPP	EEEEE	N	N	PPPPP	L	U	U	SSSSS
A A	S	P	E	N	NN	P	L	U	U	S
A A	SSSSS	P	EEEEE	N	N	P	LLLLL	UUUUU	UUUUU	SSSSS

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251 VASSAR STREET
CAMBRIDGE, MASSACHUSETTS 02139
617-497-9010

VERSION: DOS-386
RELEASE: 8.4-1
INSTALLATION: AWDHOU

HOTLINE:
U.S.A. 617-497-9010
EUROPE 31-70-3541051

JULY 4, 1991
THURSDAY
3:16:07 P.M.

MAR-25-1993 15:33 FROM EXXON SAFETY-ENU ENGR TO B-13146947049 P.007/026

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE I
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES

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MAR-25-1993 15:33 FROM EXXON SAFETY-ENV ENGR TO 8-13146947049 P.008/026

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 1
CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
RUN CONTROL SECTION

RUN CONTROL INFORMATION

THIS VERSION OF ASPEN PLUS LICENSED TO AWD TECHNOLOGIES, INC.
TYPE OF RUN: NEW

INPUT FILE NAME: RUN1.inp

OUTPUT PROBLEM DATA FILE NAME: RUN1 VERSION NO. 1
LOCATED IN: C:\ASPEN\RUN1

PDF SIZE USED FOR INPUT TRANSLATION:

NUMBER OF FILE RECORDS (PSIZE) = 99999
NUMBER OF IN-CORE RECORDS = 400
PSIZE NEEDED FOR SIMULATION = 62

CALLING PROGRAM NAME: RUN1
LOCATED IN: C:\ASPEN\RUN1

SIMULATION REQUESTED FOR ENTIRE FLOWSHEET

BLOCK STATUS

*
* ALL UNIT OPERATION BLOCKS WERE COMPLETED NORMALLY
*

MAR-25-1993 15:33 FROM EXXON SAFETY-ENV ENGR TO 8-13146947049 P.009/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 2
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 FLOWSHEET SECTION

FLOWSHEET CONNECTIVITY BY STREAMS

STREAM	SOURCE	DEST	STREAM	SOURCE	DEST
4	----	B1	3	----	B1
1	B1	----	2	B1	----

FLOWSHEET CONNECTIVITY BY BLOCKS

BLOCK	INLETS	OUTLETS
B1	3 4	1 2

COMPUTATIONAL SEQUENCE

SEQUENCE USED WAS:
 B1

OVERALL FLOWSHEET BALANCE

*** MASS AND ENERGY BALANCE ***			RELATIVE DIFF.
	IN	OUT	
CONVENTIONAL COMPONENTS (LBMOL/HR)			
C6H6	0.960135	0.960841	-0.734133E-03
H2O	9125.73	9125.73	0.728926E-07
TOTAL BALANCE			
MOLE(LBMOL/HR)	9126.69	9126.69	-0.440317E-08
MASS(LB/HR)	164475.	164475.	-0.262148E-06
ENTHALPY(BTU/HR)	-0.108604E+10	-0.108604E+10	-0.869333E-07

MAR-25-1993 15:34 FROM EXXON SAFETY-ENR ENGR TO B-13146947049 P.010/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 3
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

COMPONENTS

ID	TYPE	FORMULA	NAME OR ALIAS	REPORT NAME
C6H6	C	C6H6	C6H6	C6H6
H2O	C	H2O	H2O	H2O
LISTID			SUPERCritical COMPONENT LIST	
LIST1			C6H6 H2O	

PARAMETER VALUES

CONVENTIONAL COMPONENT - UNARY PARAMETER TABLE

PARAMETER	COMPONENTS	
NAME/SET/EL	C6H6	H2O
ZC	1 2.71000-01	2.29000-01
TC	1 5.62100+02	6.47300+02
PC	1 4.89400+06	2.20483+07
MW	1 7.81140+01	1.80150+01
PLXANT	1 1 7.38624+01	6.51544+01
	2 -5.97044+03	-6.84291+03
	3 0.0	0.0
	4 5.53760-03	2.78351-03
	5 -8.07976 00	-6.13638 00
	6 6.61298-18	3.31168-18
	7 6.00000 00	6.00000 00
	8 2.93361+02	3.19267+02
	9 5.62100+02	6.47300+02
TB	1 3.53300+02	3.73200+02
CPIG	1 1 -3.39173+04	3.37381+04
	2 4.74364+02	-7.01756 00
	3 -3.01701-01	2.72961-02
	4 7.13012-05	-1.66465-05
	5 0.0	4.29761-09
	6 0.0	-4.16961-13
	7 3.00000+02	2.00000+02
	8 1.41050+03	3.00000+03
	9 3.32560+04	3.32560+04
	10 1.10550 00	1.89780-20
	11 1.87900 00	9.28460 00
DHVLT	1 1 3.07814+07	4.06831+07
	2 3.53300+02	3.73200+02
	3 3.49117-01	3.10646-01
	4 0.0	0.0
	5 2.78700+02	2.73200+02
OMEGA	1 2.12000-01	3.44000-01
DHFORM	1 8.29824+07	-2.41997+08
DGFORM	1 1.29749+08	-2.28767+08
VLSTD	1 1 8.85091-02	1.80500-02
	2 MISSING	MISSING
	3 MISSING	MISSING
SG	1 8.84400-01	1.00000 00
API	1 2.85000+01	1.00000+01
WATSOL	1 1 4.88180 00	MISSING

MAR-25-1993 15:34 FROM EXXON SAFETY-ENV ENGR TO 8-13146947849 P.011/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 4
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

	2	-3.18137+03	MISSING
	3	0.0	0.0
	4	2.75000+02	0.0
	5	5.33000+02	1.00000+03
CHARGE	1	0.0	0.0
HIGPY	1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	0.0	0.0
	9	0.0	0.0
	10	1.00000+03	1.00000+03
PSEUDO	1	MISSING	MISSING
CPIGDP	1	4.44200+04	3.33630+04
	2	2.32050+05	2.67900+04
	3	1.49460+03	2.61050+03
	4	1.72130+05	8.89600+03
	5	-6.78150+02	1.16900+03
	6	2.00000+02	1.00000+02
	7	1.50000+03	2.27315+03
VC	1	2.58779-01	5.58953-02
RKTZRA	1	2.69017-01	2.43172-01
VCRKT	1	MISSING	MISSING
RACKET	1	MISSING	MISSING
	2	MISSING	MISSING
	3	2.85714-01	2.85714-01
VB	1	9.55084-02	1.96361-02
MUP	1	0.0	5.69210-25
LJPAR	1	MISSING	MISSING
	2	MISSING	MISSING
STKPAR.	1	MISSING	MISSING
	2	MISSING	MISSING
MUVDIP	1	3.13400-08	1.78510-07
	2	9.67600-01	8.13000-01
	3	7.90000 00	3.04720+02
	4	0.0	0.0
	5	0.0	0.0
	6	2.78680+02	3.73150+02
	7	1.00000+03	1.07310+03
TRNSWT	1	0.0	0.0
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
MULAND	1	1.16427+01	-1.22605+01
	2	1.25638+03	1.51568+03
	3	0.0	0.0
	4	2.78700+02	2.73200+02
	5	5.62100+02	6.47300+02
MULDIP	1	6.76360 00	-2.45690+02
	2	3.36410+02	9.76350+03
	3	-2.68700 00	3.83790+01

MAR-25-1993 15:34 FROM EXXON SAFETY-ENV ENGR

TO

8-13146947049 P.012/026

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 5
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

	4	0.0	-4.27430-02
	5	0.0	1.00000 00
	6	2.78680+02	2.73160+02
	7	5.45000+02	6.46150+02
KVDIP	1	1.65200-05	6.92950-05
	2	1.31170 00	1.12540 00
	3	4.91000+02	8.47680+02
	4	0.0	-1.50000+05
	5	0.0	0.0
	6	3.39150+02	3.73150+02
	7	1.00000+03	1.07310+03
KLDIP	1	2.39100-01	-4.32000-01
	2	-3.18500-04	5.72550-03
	3	0.0	-8.07800-06
	4	0.0	1.86100-09
	5	0.0	0.0
	6	2.73100+02	2.73160+02
	7	4.13100+02	6.33150+02
DVBLNC	1	1.00000 00	1.00000 00
DLWC	1	1.00000 00	1.00000 00
CHI	1	0.0	0.0
SIGDIP	1	7.19500-02	1.85480-01
	2	1.23890 00	2.71700 00
	3	0.0	-3.55400 00
	4	0.0	2.04700 00
	5	0.0	0.0
	6	2.78680+02	2.73160+02
	7	5.62160+02	6.47130+02
THRSWT	1	0.0	0.0
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	0.0	0.0
NATOM	1	6.00000 00	0.0
	2	6.00000 00	2.00000 00
	3	0.0	1.00000 00
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	0.0	0.0
	9	0.0	0.0
	10	0.0	0.0
	11	0.0	0.0
DHAQFM	1	0.0	0.0
WAGNER	1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
CPIGYM	1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0

MAR-25-1993 15:34 FROM EXXON SAFETY-ENV ENGR

TO

8-13146947049 P.013/026

ASPIEN PLUS VER: DOS-386 REL: 6.4-1 INST: AWDHOU 07/04/91 PAGE 6
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

	4	1.00000 00	1.00000 00
HCOM	1	-3.13600+09	0.0
DNLDDIP	1	1.01620 00	5.45900 00
	2	2.65500-01	3.05420-01
	3	5.62160+02	6.47130+02
	4	2.82120-01	8.10000-02
	5	0.0	0.0
	6	2.78680+02	2.73160+02
	7	5.62160+02	3.33150+02
PSANT	1	MISSING	MISSING
	2	MISSING	MISSING
	3	0.0	0.0
	4	0.0	0.0
	5	1.00000+03	1.00000+03
CPSP01	1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	0.0	0.0
	8	1.00000+03	1.00000+03
DHSFRM	1	0.0	0.0
CPSDIP	1	7.40000+03	-2.62490+02
	2	6.24900+02	1.40520+02
	3	-2.68740 00	0.0
	4	7.31600-03	0.0
	5	0.0	0.0
	6	4.00000+01	3.15000 00
	7	2.78680+02	2.73150+02
DGSFRM	1	0.0	0.0
VSPOLY	1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	1.00000+03	1.00000+03
DNSDIP	1	1.30610+01	5.30300+01
	2	-3.57140-04	-7.84090-03
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	2.73100+02	2.33150+02
	7	2.78680+02	2.73150+02
KSPOLY	1	MISSING	MISSING
	2	0.0	0.0
	3	0.0	0.0
	4	0.0	0.0
	5	0.0	0.0
	6	0.0	0.0
	7	1.00000+03	1.00000+03
GMUQR	1	3.18780 00	9.20000-01
GMUQQ	1	2.40000 00	1.40000 00
GMUQQ1	1	MISSING	MISSING

MAR-25-1993 15:35 FROM EXXON SAFETY-ENR ENGR

TO

8-13146947049 P.014/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 7
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

DHVLDP	1	1	4.75000+07	5.20530+07
	2		4.52380-01	3.19900-01
	3		5.34000-02	-2.12000-01
	4		-1.18100-01	2.57950-01
	5		0.0	0.0
	6		2.78680+02	2.73160+02
	7		5.62160+02	6.47130+02
DHVLB	1		3.07814+07	4.06831+07
VLBROC	1	1	MISSING	MISSING
	2		0.0	0.0

CONVENTIONAL COMPONENT - BINARY PARAMETER TABLES

TABLE FOR RKTKIJ SET = 1 ELEMENT = 1

C6H6		C6H6	H2O
C6H6		MISSING	MISSING
H2O		MISSING	MISSING

TABLE FOR GMUQA SET = 1 ELEMENT = 1

C6H6		C6H6	H2O
C6H6		0.0	-7.25449-02
H2O		8.29735-03	0.0

TABLE FOR GMUQB SET = 1 ELEMENT = 1

C6H6		C6H6	H2O
C6H6		0.0	-8.79403+02
H2O		-3.63749+02	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 1

C6H6		C6H6	H2O
C6H6		MISSING	7.31570+01
H2O		MISSING	MISSING

TABLE FOR HENRY SET = 1 ELEMENT = 2

C6H6		C6H6	H2O
C6H6		0.0	-6.27600+03
H2O		0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 3

C6H6		C6H6	H2O
C6H6		0.0	-8.44430 00
H2O		0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 4

C6H6		C6H6	H2O
C6H6		0.0	6.26000-06
H2O		0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 5

C6H6		C6H6	H2O
C6H6		0.0	2.78680+02
H2O		0.0	0.0

TABLE FOR HENRY SET = 1 ELEMENT = 6

C6H6		C6H6	H2O
------	--	------	-----

MAR-25-1993 15:35 FROM EXXON SAFETY-ENV ENGR

TO

8-13146947049 P.015/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 8
CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
PHYSICAL PROPERTIES SECTION

PARAMETER VALUES (CONTINUED)

C6H6	2.00000+03	5.62160+02
H2O	2.00000+03	2.00000+03

MAR-25-1993 15:35 FROM EXXON SAFETY-ENV ENGR TO 8-13146947049 P.016/026

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 9
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 U-O-S BLOCK SECTION

BLOCK: B1 MODEL: RADFRAC

INLETS - 3	STAGE 1
	4 STAGE 10
OUTLETS - 1	STAGE 1
	2 STAGE 10

PROPERTY OPTION SET: SYSOP11A UNIQUAC / REDLICH-KWONG
 HENRY-COMPS ID: LIST1

*** MASS AND ENERGY BALANCE ***			
	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(LBMOL/HR)	9126.69	9126.69	-0.440317E-08
MASS(LB/HR)	164475.	164475.	-0.262148E-06
ENTHALPY(BTU/HR)	-0.108604E+10	-0.108604E+10	-0.869333E-07

 *** INPUT DATA ***

**** INPUT PARAMETERS ****

NUMBER OF STAGES	10
ALGORITHM OPTION	STANDARD
ABSORBER OPTION	NO
INITIALIZATION OPTION	STANDARD
HYDRAULIC PARAMETER CALCULATIONS	NO
INSIDE LOOP CONVERGENCE METHOD	NEWTON
MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS	25
MAXIMUM NO. OF INSIDE LOOP ITERATIONS	10
MAXIMUM NUMBER OF FLASH ITERATIONS	50
FLASH TOLERANCE	0.000100000
OUTSIDE LOOP CONVERGENCE TOLERANCE	0.000100000

**** COL-SPECS ****

CONDENSER DUTY (W/O SUBCOOL)	BTU/HR	0.0
REBOILER DUTY	BTU/HR	0.0
MASS VAPOR DIST / TOTAL DIST		1.00000

MAR-25-1993 15:35 FROM EXXON SAFETY-ENU ENGR TO B-13146947849 P.017/025

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 10
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 U-O-S BLOCK SECTION

BLOCK: B1 MODEL: RADFRAC (CONTINUED)

***** PROFILES *****

P-SPEC	STAGE 1 PRES, PSI	16.0000
TEMP-EST	STAGE 1 TEMP, F	215.000
	10	226.000

**** TRAY MURPHREE EFFICIENCY ****

STAGE 1 EFFICIENCY	0.80000
10	0.80000

***** RESULTS *****

TOP STAGE TEMPERATURE	F	216.321
BOTTOM STAGE TEMPERATURE	F	225.364
TOP STAGE LIQUID FLOW	LBMOL/HR	8,445.37
BOTTOM STAGE LIQUID FLOW	LBMOL/HR	8,491.47
TOP STAGE VAPOR FLOW	LBMOL/HR	635.218
BOTTOM STAGE VAPOR FLOW	LBMOL/HR	824.804
CONDENSER DUTY (W/O SUBCOOL)	BTU/HR	0.0
REBOILER DUTY	BTU/HR	0.0

**** MAXIMUM FINAL RELATIVE ERRORS ****

DEW POINT	0.79318E-05	STAGE= 10
BUBBLE POINT	0.79320E-05	STAGE= 10
COMPONENT MASS BALANCE	0.43536	STAGE= 10 COMP=C6H6
ENERGY BALANCE	0.19497E-05	STAGE= 10

***** PROFILES *****

STAGE	TEMPERATURE F	PRESSURE PSI	ENTHALPY BTU/LBMOL		HEAT DUTY BTU/HR
			LIQUID	VAPOR	
1	216.32	16.000	-0.12038E+06	-0.10272E+06	
2	217.48	16.333	-0.12036E+06	-0.10293E+06	
8	223.48	18.333	-0.12025E+06	-0.10288E+06	
9	224.43	18.667	-0.12023E+06	-0.10288E+06	
10	225.36	19.000	-0.12021E+06	-0.10287E+06	

MAR-25-1993 15:36 FROM EXXON SAFETY-ENV ENGR

TO

B-13146947849 P.018/026

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 11
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 U-O-S BLOCK SECTION

BLOCK: B1 MODEL: RADFRAC (CONTINUED)

STAGE	FLOW RATE		FEED RATE			PRODUCT RATE		
	LBMOL/HR		LIQUID	VAPOR	LBMOL/HR	MIXED	LIQUID	VAPOR
1	8445.	635.2				8327.3548		
2	8456.	753.2						
8	8509.	807.9						
9	8517.	816.4						
10	8491.	824.8				799.3338	8491.4707	

STAGE	C6H6		H2O		X-PROFILE		Y-PROFILE	
	LIQUID	VAPOR	LIQUID	VAPOR	LIQUID	VAPOR	LIQUID	VAPOR
1	.94034E-06	1.0000						
2	.88002E-08	1.0000						
8	.41390E-08	1.0000						
9	.42053E-08	1.0000						
10	.42812E-08	1.0000						

STAGE	C6H6		H2O		X-PROFILE		Y-PROFILE	
	LIQUID	VAPOR	LIQUID	VAPOR	LIQUID	VAPOR	LIQUID	VAPOR
1	.15126E-02	.99849						
2	.15536E-04	.99998						
8	.78170E-05	.99999						
9	.78760E-05	.99999						
10	.79368E-05	.99999						

STAGE	C6H6		H2O		X-PROFILE		Y-PROFILE	
	LIQUID	VAPOR	LIQUID	VAPOR	LIQUID	VAPOR	LIQUID	VAPOR
1	2006.6	.99811						
2	1989.4	.99999						
8	1885.1	1.0000						
9	1869.3	1.0000						
10	1853.9	1.0000						

MAR-25-1993 15:36 FROM EXXON SAFETY-ENU ENGR TO 8-13146947049 P.019/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 12
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1	2	3	4
FROM :	B1	B1	---	---
TO :	Dist Bot	Bot	B1	B1
SUBSTREAM: MIXED			Feed	Stream
PHASE:	MIXED	MIXED	LIQUID	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9608	3.6354-05	0.9601	0.0
H2O	634.2571	8491.4707	8326.3946	799.3338
COMPONENTS: LB/HR				
C6H6	75.0522	2.8398-03	75.0000	0.0
H2O	1.1426+04	1.5297+05	1.5000+05	1.4400+04
TOTAL FLOW:				
LBMOL/HR	635.2179	8491.4707	8327.3548	799.3338
LB/HR	1.1501+04	1.5297+05	1.5007+05	1.4400+04
CUFT/HR	2.8580+05	2695.5370	2605.3892	6.5390+04
STATE VARIABLES:				
TEMP F	216.3400	225.3637	203.0000	328.1902
PRES PSI	16.0000	19.0000	16.0000	100.0000
VFRAC	0.9999	4.5946-07	0.0	1.0000
LFRAC	9.1562-06	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-1.0272+05	-1.2021+05	-1.2061+05	-1.0213+05
BTU/LB	-5673.5625	-6672.9377	-6692.6666	-5669.1577
BTU/HR	-6.5253+07	-1.0208+09	-1.0044+09	-8.1636+07
ENTROPY:				
BTU/LBMOL-R	-8.9378	-34.4782	-35.0954	-11.3910
BTU/LB-R	-0.4936	-1.9138	-1.9473	-0.6323
DENSITY:				
LBMOL/CUFT	2.2226-03	3.1502	3.1962	1.2224-02
LB/CUFT	4.0242-02	56.7507	57.6017	0.2202
AVG MW	18.1059	18.0150	18.0219	18.0150

Case 1A
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MAR-25-1993 15:36 FROM EXXON SAFETY-ENV ENGR

TO

8-13146947049

P.020/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 12
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 ----	4 ----
FROM :	---	---	B1	B1
TO :				
SUBSTREAM: MIXED	DIST	BOTT	FEED	STM
PHASE:	VAPOR	LIQUID	MIXED	VAPOR
COMPONENTS: LB/MOL/HR				
C6H6	0.9505	9.6019-03	0.9601	0.0
H2O	2.2063	8434.6739	8326.3946	110.4857
COMPONENTS: LB/HR				
C6H6	74.2499	0.7500	75.0000	0.0
H2O	39.7481	1.5195+05	1.5000+05	1990.4000
TOTAL FLOW:				
LB/MOL/HR	3.1569	8434.6835	8327.3548	110.4857
LB/HR	113.9981	1.5195+05	1.5007+05	1990.4000
CUFT/HR	9678.6162	2521.0975	5145.6537	7996.8023
STATE VARIABLES:				
TEMP F	112.9681	127.6800	113.0000	337.8307
PRES PSI	2.0000	2.1100	2.0000	114.0000
VFRAC	1.0000	0.0	1.4402-04	1.0000
LFRAC	0.0	1.0000	0.9998	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.1555+04	-1.2201+05	-1.2225+05	-1.0207+05
BTU/LB	-1704.6251	-6772.4360	-6783.2654	-5665.6518
BTU/HR	-1.9432+05	-1.0291+09	-1.0180+09	-1.1277+07
ENTROPY:				
BTU/LBMOL-R	-12.7547	-37.2867	-37.7342	-11.5627
BTU/LB-R	-0.3532	-2.0697	-2.0938	-0.6418
DENSITY:				
LB/MOL/ CUFT	3.2618-04	3.3456	1.3550	1.3816-02
LB/ CUFT	1.1778-02	60.2719	24.4197	0.2489
AVG MW	36.1104	18.0150	18.0219	18.0150

(Ans)

Basis:

5 theor. trays
 Murphree eff. = 80%
 Press. = 2 psia

MAR-25-1993 15:37 FROM EXXON SAFETY-ENU ENGR TO 8-13146947049 P.021/026

ASPEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 ----	4 B1
FROM :				
TO :				
SUBSTREAM: MIXED	DIST	BOTT	FEED	STM
PHASE: MIXED	MIXED	LIQUID	MIXED	VAPOR
COMPONENTS: LB/MOL/HR				
C6H6	0.9505	9.6013-03	0.9501	0.0
H2O	2.2962	8441.8421	8326.3946	117.7336
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	41.1862	1.5208+05	1.5000+05	2120.9720
TOTAL FLOW:				
LB/MOL/HR	3.2367	8441.8517	8327.3548	117.7336
LB/HR	115.4362	1.5208+05	1.5007+05	2120.9720
CUFT/HR	4199.6948	2575.0983	2890.1705	8321.3998
STATE VARIABLES:				
TEMP F	147.8055	162.4570	147.7000	337.8307
PRES PSI	5.0000	5.0510	5.0000	114.0000
VFRAC	0.9999	0.0	3.4361-05	1.0000
LFRAC	6.6382-05	1.0000	0.9999	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.2182+04	-1.2138+05	-1.2163+05	-1.0207+05
BTU/LB	-1743.5510	-6737.6302	-6748.9388	-5665.6518
BTU/HR	-2.0127+05	-1.0247+09	-1.0128+09	-1.2017+07
ENTROPY:				
BTU/LBMOL-R	-13.6870	-36.2509	-36.6854	-11.5627
BTU/LB-R	-0.3837	-2.0122	-2.0356	-0.5418
DENSITY:				
LBMOL/CUFT	7.7071-04	3.2782	3.8812	1.3816-02
LB/CUFT	2.7487-02	59.0581	51.9260	0.2489
AVG MW	35.6642	18.0150	18.0219	18.0150

(NSC)

BASIS:

TH. TRAYS = 5
 EFF. = 80%
 PRESS. = 5 PSIA

MAR-25-1993 15:37 FROM EXXON SAFETY-ENV ENGR TO B-13146947049 P.022/1026

ASPER PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 B1	4 B1
FROM :				
TO :				
SUBSTREAM: MIXED	DIST	BOTT	FEED	STM
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LB/MOL/HR				
C6H6	0.9505	9.6013-03	0.9601	0.0
H2O	2.4292	8445.7100	8326.3946	121.7445
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	43.7627	1.5215+05	1.5000+05	2193.2282
TOTAL FLOW:				
LB/MOL/HR	3.3797	8445.7196	8327.3548	121.7445
LB/HR	118.0127	1.5215+05	1.5007+05	2193.2282
CUFT/HR	3002.5707	2503.8096	2545.4081	8811.7027
STATE VARIABLES:				
TEMP F	165.3560	180.0205	165.2000	337.8307
PRESS PSI	7.5000	7.5375	7.5000	114.0000
VFRAC	0.9999	0.0	0.0	1.0000
LFRAC	8.9507-05	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.3721+04	-1.2106+05	-1.2131+05	-1.0207+05
BTU/LB	-1824.9184	-6719.7861	-6731.3423	-5665.6518
BTU/HR	-2.1536+05	-1.0224+09	-1.0102+09	-1.2426+07
ENTROPY:				
BTU/LBMOL-R	-13.8578	-35.7435	-36.1720	-11.5627
BTU/LB-R	-0.3968	-1.9840	-2.0071	-0.6418
DENSITY:				
LB/MOL/CUFT	1.1256-03	3.2436	3.2715	1.3816-02
LB/CUFT	3.9304-02	58.4337	58.9591	0.2489
AVG MW	34.9173	18.0150	18.0219	18.0150

Basis:

TN. TRAYS = 5
EFF. = 80%
PRESS. = 7.5 PSIA

MAR-25-1993 15:37 FROM EXXON SAFETY-ENR ENGR TO 8-13146947849 P.023/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: ANDHOU 07/04/91 PAGE 13
CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 B1	4 B1
FROM :				
TO :	DIST	BOTT	FEED	STM
SUBSTRATE: MIXED	MIXED	LIQUID	LIQUID	VAPOR
PHASE:				
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.6013-03	0.9601	0.0
H2O	2.5595	8448.4336	8326.3946	124.5985
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	46.1107	1.5220+05	1.5000+05	2244.6428
TOTAL FLOW:				
LBMOL/HR	3.5101	8448.4432	8327.3548	124.5985
LB/HR	120.3607	1.5220+05	1.5000+05	2244.6428
CUFT/HR	2384.5151	2626.0391	2565.8456	9018.2704
STATE VARIABLES:				
TEMP F	178.6160	193.2547	178.4000	337.8307
PRES PSI	10.0000	10.0288	10.0000	114.0000
VFRAC	0.9998	0.0	0.0	1.0000
LFRAC	1.0572-04	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.5036+04	-1.2081+05	-1.2107+05	-1.0207+05
BTU/LB	-1896.6603	-6706.2332	-6717.9295	-5665.6518
BTU/HR	-2.2828+05	-1.0207+09	-1.0082+09	-1.2717+07
ENTROPY:				
BTU/LBMOL-R	-13.9376	-35.3678	-35.7909	-11.5627
BTU/LB-R	-0.4064	-1.9632	-1.9859	-0.6418
DENSITY:				
LBMOL/CUFT	1.4720-03	3.2171	3.2454	1.3816-02
LB/CUFT	5.0476-02	57.9577	58.4894	0.2489
Avg MW	34.2897	18.0150	18.0219	18.0150

Basis:

TH. RAYS = 5
EFF. = 80%
PRESS. = 10 PSIA

MAR-25-1993 15:38 FROM EXXON SAFETY-ENV ENGR

TO

B-13146947049 P.824/1026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
 CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
 STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 ---	4 B1
FROM :	---	---	---	---
TO :	---	---	---	---
SUBSTREAM: MIXED	DIST	BOTT	FEED.	STM
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LBMOL/HR				
C6H6	0.9505	9.6013-03	0.9601	0.0
H2O	2.6283	8451.3297	8326.3946	127.4634
COMPONENTS: LB/HR				
C6H6	74.2500	0.7500	75.0000	0.0
H2O	47.3493	1.5225+05	1.5000+05	2296.2538
TOTAL FLOW:				
LBMOL/HR	3.5788	8451.2393	8327.3548	127.4634
LB/HR	131.5993	1.5225+05	1.5007+05	2296.2538
CUFT/HR	2050.9071	2641.3509	2579.4486	9225.6272
STATE VARIABLES:				
TEMP F	187.2610	201.9925	187.0000	337.8307
PRES PSI	12.0000	12.0242	12.0000	114.0000
VFRAC	0.9998	0.0	0.0	1.0000
LFRAC	1.1744-04	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-6.5668+04	-1.2065+05	-1.2091+05	-1.0207+05
BTU/LB	-1932.7228	-6697.2136	-6709.1368	-5665.6518
BTU/HR	-2.3502+05	-1.0196+09	-1.0069+09	-1.3010+07
ENTROPY:				
BTU/LBMOL-R	-14.0211	-35.1226	-35.5456	-11.5627
BTU/LB-R	-0.4126	-1.9496	-1.9723	-0.6418
DENSITY:				
LBMOL/CUFT	1.7450-03	3.1995	3.2283	1.3816-02
LB/CUFT	5.9291-02	57.6408	58.1810	0.2489
AVG MW	33.9770	18.0150	18.0219	18.0150

BASIS:

TH. TRAYS = 5
 EFT = 80%
 PRESS = 12 PSIA

MAR-25-1993 15:38 FROM EXXON SAFETY-ENV ENGR TO 8-13146947049 P.025/026

ASPIEN PLUS VER: DOS-386 REL: 8.4-1 INST: AWDHOU 07/04/91 PAGE 13
CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 --- B1	4 --- B1	CASE 2
FROM :	---	---	---	---	
TO :	---	---	---	---	
SUBSTREAM: MIXED	DIST	BOTT	FEED.	STM	
PHASE:	MIXED	LIQUID	LIQUID	VAPOR	
COMPONENTS: LB/MOL/HR					
C6H6	0.9505	9.5935-03	0.9601	0.0	
H2O	2.7358	8451.9487	8326.3946	128.2898	
COMPONENTS: LB/HR					
C6H6	74.2506	0.7493	75.0000	0.0	
H2O	49.2858	1.5226+05	1.5000+05	2311.1419	
TOTAL FLOW:					
LB/MOL/HR	3.6863	8451.9583	8327.3548	128.2898	
LB/HR	123.5364	1.5226+05	1.5000+05	2311.1419	
CUFT/HR	1830.2904	2654.3663	2591.8276	9285.4427	
STATE VARIABLES:					
TEMP F	194.9944	209.6017	194.7000	337.8307	
PRES PSI	14.0000	14.0212	14.0000	114.0000	
VFRAC	0.9995	0.0	0.0	1.0000	
LFRAC	1.2622-04	1.0000	1.0000	0.0	
SFRAC	0.0	0.0	0.0	0.0	
ENTHALPY:					
BTU/LBMOL	-6.6671+04	-1.2051+05	-1.2077+05	-1.0207+05	
BTU/LB	-1989.4933	-6689.3325	-6701.2283	-5665.6518	
BTU/HR	-2.4577+05	-1.0185+09	-1.0057+09	-1.3094+07	
ENTROPY:					
BTU/LBMOL-R	-14.0130	-34.9111	-35.3280	-11.5627	
BTU/LB-R	-0.4181	-1.9378	-1.9602	-0.6418	
DENSITY:					
LB/MOL/CUFT	2.0141-03	3.1841	3.2129	1.3816-02	
LB/CUFT	6.7495-02	57.3630	57.9031	0.3489	
Avg MW	33.5117	18.0150	18.0219	18.0150	

Basis:

70 TRAYS = 5
EFF = 80%
PRESS. = 14 PSIA

MAR-7-1993 15:38 FROM EXXON SAFETY-ENV ENGR TO 8-13146947049 P.026/026

ASPIRE PLUS VER: DOS-386 REL: 3.4-1 INST: AWDHOU 07/04/91 PAGE 13
CHEMICAL MANUFACTURERS ASSOC. SIMULATION STUDIES
STREAM SECTION

1 2 3 4

STREAM ID	1 B1	2 B1	3 B1	4 B1
FROM :				
TO :				
SUBSTREAM: MIXED	DIST	BOTT	Feed	STW
PHASE:	MIXED	LIQUID	LIQUID	VAPOR
COMPONENTS: LB/MOL/HR				
C6H6	0.9505	8.5950-03	0.9601	0.0
H2O	2.8044	8453.8155	8326.3946	130.2253
COMPONENTS: LB/HR				
C6H6	74.2504	0.7495	75.0000	0.0
H2O	50.5217	1.5230+05	1.5000+05	(2346.0096)
TOTAL FLOW:				
LB/MOL/HR	3.7549	8453.8251	8327.3548	130.2253
LB/HR	124.7722	1.5230+05	1.5007+05	2346.0096
CUFT/HR	1846.2341	2666.4957	2602.7570	9425.5303
STATE VARIABLES:				
TEMP F	201.7299	216.3655	(201.4000)	337.8307
PRES PSI	16.0000	16.0203	16.0000	114.0000
VFRAC	0.9998	0.0	0.0	1.0000
LFRAC	1.3538-04	1.0000	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0
ENTHALPY:				
BTU/LBMOL	-5.7259+04	-1.2038+05	-1.2064+05	-1.0207+05
BTU/LB	-2024.1318	-6682.2996	-6694.3193	-5665.6518
BTU/HR	-2.5256+05	-1.0177+09	-1.0046+09	-1.3292+07
ENTROPY:				
BTU/LBMOL-R	-14.0528	-34.7244	-35.1401	-11.5627
BTU/LB-R	-0.4229	-1.9275	-1.9498	-0.6418
DENSITY:				
LB/MOL/CUFT	3.2809-03	3.1703	3.1994	1.3816-02
LB/CUFT	7.5793-02	57.1147	57.6600	0.2489
AVG MW	33.2285	18.0150	18.0219	18.0150

BEST:
TR. TRAYS = 5
EFF = 80%
PRESS. = 16 PSIA

Comments on the EPA Basis for Steam Stripper
Reference Control Technology

Prepared by: B. C. Davis, Exxon Chemical Co., March 22, 1993

Background

The EPA has proposed steam stripper as reference control technology for the Wastewater HON. If a steam stripper is designed and operated to the EPA specifications, no performance testing is required, only monitoring of process variables is needed to assure desired removal performance is occurring.

~~The EPA specifications for Steam Stripper Reference Control Technology are:~~

- 1. Minimum active column height - 5 m
- 2. Counter current flow - min 10 theoretical trays
- 3. Minimum steam flow - 0.096 kg steam/l ww flow - *0.096 lb steam gal ww*
- 4. Minimum ww feed temp - 35 deg C.
- 5. Maximum liquid loading of 39,900 l/hr⁻¹ m⁻²
- 6. Water cooled Cond vapor outlet temp - 50 deg C

~~The EPA used ASPEN as the process simulation package to derive these specifications. In the BID document, the EPA used benzene/water as a case study upon which these specifications were derived.~~

Purpose of this Work

The purpose of this work is to review EPA's specifications for the benzene water system and show that a steam stripper operating at different conditions can achieve the same benzene removal.

Problem Basis Statement:

Feed Flow	300 gal/min
Contamination	500 ppm Benzene
Removal Target	99 %

Number of Equilibrium Stage	5
Murphree Tray Efficiency	80
Data Source for Properties	DIPPR
Process Simulation Package	ASPEN Release 8.4-1

Larry,
 [REDACTED] This is benzene water separation
 case. Looking for OH concentration.
 Chg # 3-9153

Results to Achieve 99 % Benzene Removal at minimum Steam/Feed Ratios and varying steam pressure

Tower Pressure psia	Steam Rate lbs/hr	Steam/ Feed Ratio
16	4000	0.0267
16	2346	0.0156
14	2311	0.0154
12	2296	0.0153
10	2245	0.0150
7.5	2193 ²¹⁹⁰	0.0146
5	2191	0.0141
2	1990	0.0133

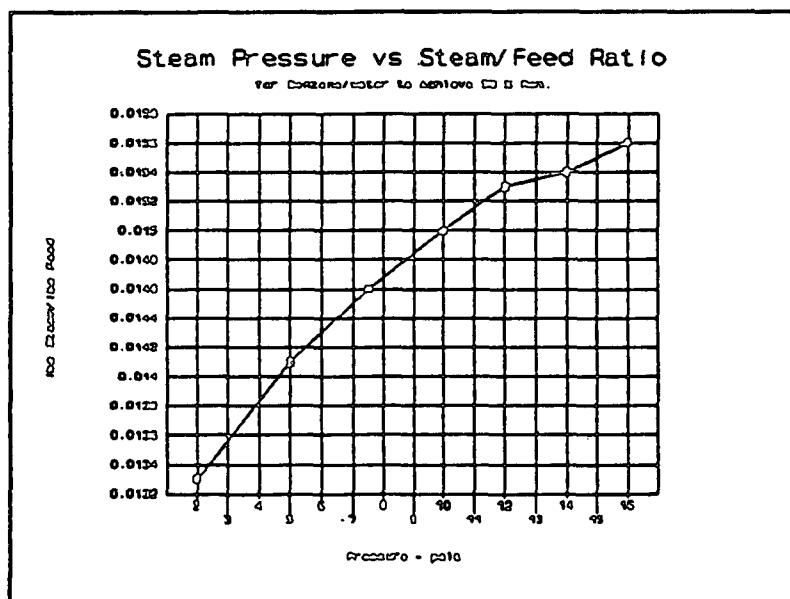
Analysis/Comments

1. The steam to feed ratio specified as reference control technology 0.096 by the EPA is too high for this system. If this amount of steam were used, too much water would be carried overhead resulting in too dilute an overhead stream, resulting in difficulty splitting the benzene/water mixture. The water in the overhead stream is recycled back to the feed, too much water would need to be recycled.
2. The usual method for designing a steam stripping system is to:
 - 2.1 Identify a key component which is most difficult to remove based on concentrations and physical properties. The design basis can be verified through the use of pilot plant studies or the use of properties and design procedures based on prior experience with similar systems. Process simulation computer packages are used to establish the process design parameters and predict the removal performance.
 - 2.2 Design to remove the key component at the target removal efficiency. The minimum amount of steam is used to achieve the target removal efficiency. This amount of steam is determined by exercising the process simulation computer program. Other compounds present will have a higher removal efficiency than the key compound.
 - 2.3 The choice of tray efficiency is based on experience and available performance data for the design basis mix of compounds and compositions. The choice of an 80 % Murphree tray efficiency was chosen for this example only. A choice of efficiency is based on design experience and depends on whether vapor liquid equilibrium or mass transfer is controlling the separation. The choice of tray efficiency is also a function of the tray or packing type and design. For some systems the tray efficiency can be 50 percent or lower.

4. The concept of specifying a uniform steam to feed mass ratio for all columns and all mixes of chemicals will not result in the best operating scenario for any one individual system. For the benzene/water system at 500 ppm, the EPA design steam rate over 6 times too high.
5. The steam to feed ratio is not a good way to specify steam distillation performance. The steam to feed ratio to achieve a percentage removal target is a function of influent concentration for a given system. A better specification approach is to use the vapor overhead to feed ratio. This ratio is not a strong function of influent concentration and is used the control parameter to achieve a bottoms target concentration in many systems. Keeping this ratio constant tends to result in uniform removal performance for a given system based on the performance of a key component.

Conclusions/Recommendations

1. We conclude that one set of generic parameters to set the design parameters for all steam strippers will not work. We recommend that case by case (system by system) performance and operating parameters be determined through the use of verified process simulation modelling studies.
2. For the benzene/water system examined for these studies, a range of steam to feed ratios is possible to achieve a 99 % removal. Steam Strippers operating at vacuum conditions down to as low as 2 psia, can achieve 99 % benzene removal at lower stream to feed ratios as compared to an atmospheric system.



APPENDIX O

LPS 1993

Proceedings of the

27th Annual Loss Prevention Symposium

Thomas O. Gibson
Symposium Chair
The Dow Chemical Company

Joseph A. Senecal
Symposium Vice-Chair
Fenwal Safety Systems, Inc.

Joseph F. Louvar
Committee Chair
BASF Corporation

Daniel A. Crowl
Committee Vice-Chair
Michigan Technological Univ.

Sponsored by the
American Institute of Chemical Engineers
Safety and Health Division
11a-Loss Prevention Committee

George R. Brown Convention Center
Houston, TX
March 29 – April 1

[10]

**Wednesday, March 31
8:30-11:30 am
Ballroom A**

27th LOSS PREVENTION SYMPOSIUM

IV-LOSS PREVENTION IN PLANT DESIGNS

SPONSORED BY GROUP IIIA-SAFETY & HEALTH DIVISION

David Kirby, Chair
Union Carbide Corporation
P.O. Box 8361
S. Charleston, WV 25303

David A. Bosworth, Co-Chair
Mobil Research & Development Co.
P.O. Box 1026
Princeton, NJ 08543-1026

Session Introduction - 8:30 am D. Kirby

Vapor Suppression of Chemicals Using Foam

Paper No. 10a

8:35 am

N. E. Scheffler (Speaker), L. S. Green & D. J. Frump, The Dow Chemical Company, Midland, MI

Failure and Design Limit Criteria for Blast Loaded Structures

Paper No. 10b

9:00 am

D. D. Barker (Speaker), M. G. Whitney & J. H. Waclawczyk, Wilfred Baker Engineering, Inc., San Antonio, TX

In Line (Detonation) Flame Arresters – Function, Certification, Selection and Application

Paper No. 10c

9:25 am

T. Knittel, Westech Industrial Inc., Webster, TX

Break

9:50 am

Use and Installation of Portable Tanks for Flammable Liquids

Paper No. 10d

10:00 am

A. J. Torres, Jr. (Speaker) & T. J. Simmons, Eastman Kodak Company, Rochester, NY

Ethylene Oxide Explosion at Seadrift, Texas – Reboiler Safety

Paper No. 10e

10:25 am

L. L. Simpson (Speaker) & P. E. Minton, Union Carbide Corporation, S. Charleston, WV

Liquid Drainage and Containment for Safe Plant Operations

Paper No. 10f

10:50 am

O. M. Slye, Jr., Loss Control Associates, Inc.

Closing Remarks – D. A. Bosworth

LIQUID DRAINAGE AND CONTAINMENT FOR SAFE PLANT OPERATIONS

Presented by
Orville M. Slye, Jr., P.E.
President
Loss Control Associates, Inc.

American Institute of Chemical Engineers
April 1993

Drainage systems in facilities handling or storing flammable or combustible liquids should be designed to minimize the spread of spills or fire beyond the area of origin. To provide safeguards against fire spread by hydrocarbons floating on water or hydrocarbons pool fires, drainage systems should include the following:

- Means for rapid removal of hydrocarbon spills and/or firewater to a remote location without spreading fire to adjacent areas.
- Any spill surface areas and reduce the potential for light hydrocarbon vaporization and the size of any potential fire.

Fires and explosions have occurred where hydrocarbons traveled extensive distances in sewers or across process unit paving before ignition. The resulting fire or explosion has resulted in fatalities, injuries and property losses from fire and/or explosion damage and loss of plant production. A common scenario is the spread of hydrocarbons floating on water from fire fighting which flows to adjacent areas not initially involved in the incident. In one location, hydrocarbons collected on the surface of fire fighting water which accumulated as the result of an instrument air failure. The air failure shut down the instrument air system which powered the control for a sewer system pump designed to remove oily water and storm water to a safe location. When the pump failed floating, burning and unignited hydrocarbons spread through the process and utilities areas. Firefighters were subjected to high water in many plant areas, some as high as waist level. In another incident, a heavy storm flushed retained hydrocarbons from the sewer system and spread the hydrocarbon off site to adjacent public and plant areas where they became ignited and resulted in major losses in the adjacent companies facility and in the plant of origin. In other incidents inadequate drainage seals or the inability to provide for rapid removal of spilled hydrocarbons and water resulted in extensive spread of fire through process areas.

A key design factor in drainage systems is the relationship between the system size and the water used for firefighting.

Systems should be arranged to minimize potential for spill, fire, and exposure to key operating equipment. The draining system should be sized to remove at least the design quantity of water of the firefighting equipment provided in the facility and should safely remove hydrocarbons to remote areas from the fire incident without spreading the fire through large areas of the plant.

SAFE DRAINAGE ARRANGEMENTS IN OUTDOOR FACILITIES

Drainage systems in a large petrochemical, refining or chemical facility consist of at least four separate sub-systems, including:

- Grading and Paving
- Catchment Basins and their sizing
- Sewers and Open Ditches and their arrangement
- Containment Basins

Grading and Paving

Spills and firefighting runoff water can be diverted to a safe location or away from vital equipment by properly graded paving. The arrangement of the paving system has a direct impact on equipment spacing and layout as well as the extent and types of firefighting protection equipment. When paving is properly graded fire exposure from spilled hydrocarbons to equipment and important areas is considerably reduced.

Paving Materials - Concrete paving or materials such as stone are the most commonly used paving material. Concrete is the most effective paving material since it is not easily deteriorated or affected by hydrocarbon spills. Since concrete has high durability when properly installed it is not easily cracked to allow hydrocarbons to penetrate through the pavement into ground water. Concrete is non-combustible and prevents spills from leaching into the soil which provides a number of positive factors over designs using permeable, easily altered or modified materials.

Asphalt is not an acceptable material for paving in those areas where hydrocarbons can spill on the surface. Asphalt is combustible and can contribute to fire spread in a process unit. Loose stone, gravel, cliche (shell) are commonly used in those areas with a minimum spill potential but should be avoided in hydrocarbon liquid handling process areas. Typical areas where these materials include offsite areas adjacent to paved surfaces within the process unit can be used under non-unit pipeways or secondary utility areas adjacent to hydrocarbon process areas. A design factor which should be carefully monitored is that loose materials can allow spills to easily enter ground water.

Grading Slope - The arrangement of the paving surface will

accentuate flow to a safe removal system. In design of the grading, the slope of a paving surface should consider the following factors:

1. Slope of the paving should be at least one inch in ten feet so that spills or water from firefighting activities or storm water will flow rapidly to the sewer inlet.
2. Determine paving slope early in the design to determine catch basin location and finalize the underground piping connections such as drain hubs and inlets. Hard surfaced areas will retain slope but gravel or loose materials will require routine maintenance to maintain the acceptable safe slope. It is a matter of fact that once the paving has been installed it is extremely difficult to re-arrange paving slope to provide a safe arrangement within a process unit. Careful consideration needs to be provided in equipment arrangement and in paving design to insure for a safe arrangement early in the design of the project.
3. Pavement should be sloped away from equipment to catch basins and drainage low spots. Low spots and drainage inlets should be located so that any pool of flammable liquids floating on water forms in a safe location away from firefighting equipment, access and passageways, and process equipment access areas. Numerous design checks will be required to assure that inlets are not placed under personnel walkways, equipment, or safety systems. High spots of drainage should be placed under pipeways and at edges of the paving so that flow of liquids is away from such areas to catch basin inlets.
4. Draining or curbing which is judiciously located will prevent spills from running off of process unit paving to adjacent areas, or to the ground where it can contaminate ground water or collect in areas where hydrocarbons could appreciably increase hazards.

High points of paving grade can be used to define the limits of a drainage zone. A drainage zone is the area of the paving which feeds an individual inlet or separates high from low hazard areas to prevent spread of fire between adjacent areas and within the process unit. Locating a high point of grade under pipeways and heaters assures that flows from adjacent area will not enter under these valuable areas within the unit and create extensive equipment fire exposure. As an example, a high spot under a heater prevents flow of spills into any adjacent areas where they could easily be ignited. Curbing should be limited to minimize unsafe tripping hazards when visibility is poor such as in smoke, vapor or periods of low lighting. Curbs allow spills to fill the

contained area and resulting fires are difficult to extinguish due to the liquid depth of the spill. Hydrocarbon fires are more difficult to control and extinguish when in depth versus those that are relatively thin coatings on water or on paving surfaces. In some areas curbing adds to the hazard since it creates hydrocarbon pools which when ignited can result in extensive long term fire exposure to equipment placed within the curbed area.

The design of paving and grading should take into consideration any impact on the environment. Paving high spots or curbing should separate spills and rainwater flow between wastewater or storm water systems. This arrangement will reduce the overload of waste water treatment units and storm pond capacity.

Catchment Basins

Catchment basins (drain inlets) collect water from paving into an oily water or stormwater sewer system. Typically, the oily water sewer is that system connected to the waste water treatment plant.

Storm water system typically requires less environmental control and treatment than the oily water sewer. Storm water systems convey and dispose rain water that falls in those plant areas which are not subject to hydrocarbon spills such as roadways and office areas. The design of a process unit sewer, sometimes termed the oily water or hydrocarbon sewer, should consider the following points:

- Catch basins should be fitted with a fire seal unless required to be a dry box type catch basin. The most common fire seal is an elbow placed in the sewer box inlet line to prevent the passage of vapor and fire to upstream inlets such as the preceding catch basin or a drain hub. A typical catch basin with fire seal is illustrated in Figure 1.
- Catch basins should be sized so that the maximum rainfall or firewater use will not exceed their capacity. Since this may not be possible in tropical areas or areas with high rainfall, catch basins should be served by drainage areas which are sized for each inlet capacity. In general practice the size of the drainage area for a catch basin is a maximum of 2,500 square feet.
- A dry box is arranged so that spills drain out to a manhole or sewer system connection and do not remain in the drainage inlet box. Dry boxes are provided in areas near heaters or other ignition sources that could ignite any accumulated liquids vaporized from the inlet. The rule of thumb is to provide dry boxes for any catch basin inlets within thirty feet of a heater or other continuous ignition source. The drain line should be fitted with a fire seal at the point